

OUR BLUE PLANET

Exploring human impacts on the ocean
and what we can do to protect it

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50
YEARS



Our Blue Planet

Welcome to our booklet designed to help you discover the challenges the ocean, and the creatures and plants that live in it, currently face.

The impact of human activity on the ocean is profound and has resulted in, amongst other things, changes in the temperature and chemistry due to global warming, changes in animal migration patterns, coral bleaching, and a dramatic increase in numerous forms of pollution. We have not covered every human impact in this booklet but have taken a selection of those that have attracted most attention in the press. We then looked at these in a little more detail and have highlighted some of the facts and figures around these issues that might have caught your attention.

It is easy to feel that the damage is now so extensive, and the multiple challenges so great, that very little can be

done. In fact nothing could be further from the truth. The dedicated work of scientists from around the globe have highlighted that the problems we have created also have potential solutions. What is becoming evident, is that as time goes on, these problems will not be resolved unless governments and organisations take decisive action and attitudes towards the ocean and its inhabitants change. That doesn't mean we, as individuals, can sit back and simply hope for change. Individual action, whether it is actively managing our own waste generation or putting pressure on our representatives to pass legislation, has been and always will be important. We all have a role to play in keeping our Blue Planet healthy.

Blue Planet Live

Across a week in March 2019, BBC One broadcast live to celebrate marine life both great and small, taking the audience on a deep dive into the world's ocean in Blue Planet Live.

More at www.open.edu/openlearn/blueplanetlive



The Ocean and Climate Change

Looking at the Earth from space we can see that it is a blue planet with ocean covering 70% of its surface.

We also know from what we find on beaches that the oceans circulate and transport debris. This can be human-derived rubbish and plastic or natural materials such as tree trunks. This ocean circulation has a profound effect on our climate. In most cars, water is pumped around cooling systems to move heat away from the engine. Our planet works in a similar way, with the ocean currents moving heat around. However, instead of a pump to move the water, we have our climate system. Ocean currents therefore regulate the global climate.

Solar energy reaching the Earth is relatively intense at the equator, but in the Arctic and Antarctic it is much weaker. Here, ocean surface water is cold enough to freeze and is dense enough to sink, sometimes

reaching the sea floor. At lower latitudes warmer water is less dense. With dense water sinking and warm water rising, a global three-dimensional circulation pattern develops, that links all seas and oceans which are not isolated by land masses.

It is this circulation pattern that drives the warm water in the Gulf Stream and North Atlantic Drift towards Northern Europe and is responsible for our relatively moderate climate. For example, on the west side of the North Atlantic, Halifax in Nova Scotia has mean January temperatures of about -6°C .



However, Southampton, which is further from the equator than Halifax, has a mean January temperature of $+5^{\circ}\text{C}$. We understand now that the ocean also controls our climate on a longer timescale and that during the planet's ice ages, its circulation was very different.

Atmospheric warming

As our atmosphere has warmed during the industrial era, the Earth's climate system has been affected, with much of the extra heat on our planet being absorbed by the ocean. There is now substantial evidence that the surface waters have, on average, warmed over the last 50 years.

This warming is in part responsible both for coral bleaching and changes in many animals' migration patterns. It is also responsible for some more subtle effects. As well as raising the temperature of the atmosphere, greenhouse gases such as carbon dioxide (CO₂) are, in some key locations, absorbed by the ocean thereby slowing the overall increase in atmospheric temperature.

CO₂ absorption

CO₂ absorption also fundamentally changes the chemistry of sea water making it more acidic, a process known as ocean acidification. This can affect the growth of organisms such as coral, and also animals with shells such as clams, mussels and other shellfish.

While it is true that some plants and algae such as seaweeds may flourish in a high CO₂ world, the increasing absorption of CO₂ by the ocean combined with elevated ocean temperatures and a changing climate will have a profound effect on the ocean and the marine ecosystems it supports.



Did you know?

- A continual global circulation of water links all oceans and it takes about 400 years for the ocean conveyor belt to turn the ocean's waters and make one complete trip around the Earth.
- The heat from the North Atlantic Ocean is what gives Northern Europe its moderate climate with relatively warm winters and cool summers.
- As CO₂ that we have emitted into the atmosphere is absorbed, the acidity of the ocean changes, negatively affecting marine life.

Good News



What can we do?

Because most of the heating we have added to our planet through burning fossil fuels has ended up in the ocean, and CO₂ take up has an effect on ocean acidity, our response has to be to urge governments to support the decarbonisation of our economy as rapidly as possible. Reducing your own carbon usage for example by driving and flying less will help, but it is public pressure that will really make a difference.



Animal Migration in a Changing Ocean

As the ocean warms, becomes more acidic and the sea ice retreats, the timing of and distances travelled by long distance migrating marine species is changing.

Some of the most spectacular and longest animal migrations on earth occur in the ocean, triggered by local climate, food availability or for breeding purposes. Migration of marine organisms can take many forms, from the daily vertical migrations of plankton, to the migration of fish species to and from their spawning grounds. Perhaps the most spectacular are the seasonal migrations of whales that may travel thousands of kilometres between their summer feeding and winter calving grounds.

Global warming poses particular challenges to migratory species since they face changes to different habitats that they occupy during migration. In the ocean global warming has resulted in, amongst other

things, higher sea surface temperatures, increased acidity and the melting and retreating of sea ice. For large long distance migrating species, such as whales, these factors are likely to affect migration patterns due mainly to changes in the availability of food at their calving and feeding grounds.

The largest animals on earth, blue whales, embark on annual migrations of approximately 2000 km that take them from cold nutrient rich foraging grounds near the Arctic and Antarctic regions to warm tropical calving grounds nearer the equator. Both calving and foraging grounds are unique areas of upwelling that support large populations of plankton including small crustaceans known as krill, upon which blue whales feed almost exclusively. The length of the migration means that whales depend on stability of food both at the foraging and calving grounds in order to replenish energy supplies. Although the effects of global warming on blue whale migrations is as yet unclear, there is some evidence that changes in sea temperature and acidity is shifting the populations of krill to new areas, and that in order to survive whales are altering their migration paths and the timing of migration. The increasing reduction in sea

ice in the Arctic has already had the effect of contracting the distribution of krill in a northerly direction, not only decreasing the blue whale's foraging area but also forcing them to migrate further north. This increases the length of their southerly migration back to their calving grounds and increases the energetic cost of migration.

Changes in migration timing

A reduction in temporal ice coverage in the Arctic, due to increasing sea surface temperature, has had the effect of changing the timing of migration in humpback whales. They now arrive earlier at their feeding grounds to coincide with earlier phytoplankton blooms upon which their main prey, krill, depend. They also stay longer, following the krill that retreat with the sea ice. In populations that migrate north to their feeding grounds, this change in migration timing means that humpback whales arrive at the same time as fin whales (that traditionally arrive earlier). Both species feed on the same prey so that their coincidental arrival increases competition between them for food.

Although whales are highly adaptable, having survived several fluctuations in climate over the past 80,000 years, it remains questionable as to how well they will adapt to further rapid environmental change. Krill, upon which many whales depend for food, is highly sensitive to both acidification and rising sea temperature. Large decreases in krill biomass has already been seen in some parts of the Antarctic.



Did you know?

- Changes in ocean chemistry and temperature may favour some species that become widely distributed. This will come at a cost to species that are unable to cope with these changes.
- Blue whale poo (faeces) is extremely rich in iron that triggers phytoplankton blooms. Krill eat phytoplankton and are in turn eaten by whales.
- Blue whale songs have decreased in loudness and pitch over several decades. One explanation is that changes in ocean chemistry and temperature affects how sound travels.

Good News



Shark conservation

Scientists estimate that one quarter of sharks and ray species worldwide are threatened with extinction. The Memorandum of Understanding of Migratory Sharks (Sharks MOU) is an international conservation plan that aims to conserve migratory shark and ray populations by enhancing national, regional and international cooperation. As of December 2016, 39 national governments as well as the EU were signatories to the plan.



Worldwide, Coral Reefs are under Threat

Tropical coral reefs are under threat and their long-term survival is in question. But, there is still hope for the future.

Tropical coral reefs are probably the most diverse ecosystems in the ocean but at present, many are suffering from the effects of climate change. A sudden sharp increase in sea temperature has the effect of turning them white, a process known as bleaching, where the underlying white skeleton of the coral is exposed. Bleaching results from the expulsion of small colourful microalgae called zooxanthellae, which normally live inside the tissues of the coral and in exchange furnish the coral with up to 90% of its energy requirements. Corals, which are technically animals not plants, can survive bleaching but it is a sign of extreme physiological and nutritional stress and if they do not regain their algae quickly enough, they may eventually die of starvation. Recent occurrences of bleaching

events, such as those that took place on the Great Barrier Reef in 1998, 2002, 2016 and 2017, have led to the catastrophic loss of large areas of coral reefs, making headlines and drawing worldwide attention.

Bleached for hundreds of years, why so bad now?

Coral has bleached for hundreds of years. A recent study suggests that coral bleaching has happened on numerous occasions in the past. Scientists have found that coral colonies, that can live for hundreds

of years, lay down growth rings, much like the annual growth rings found in tree trunks. These rings provide information about past events, including changes in sea temperature and bleaching. Analysis of the rings show that although bleaching has



happened during the past 400 years, such occurrences have been quite rare and coral has been able to recover between events.

Scientists studying more recent bleaching incidences, between 1980 and 2016, have shown that since the 1980s the frequency of severe bleaching events has increased fivefold in the past 40 years. Increasing from once every 25 to 30 years in the early 80s to once every 6 years in 2016. Such a narrow recovery window does not allow for a full recovery of mature assemblages of coral (a process that takes about 10 to 15 years for the fastest growing species), before bleaching occurs again.

Is there time for recovery?

The possibility now exists that climate change will continue to increase the frequency of extreme heating events on coral reefs, reducing the recovery window even further and increasing the likelihood of annual bleaching events in the coming decades and leaving no time for recovery. Without a concerted effort to reduce climate change, it seems likely that a warming ocean and other human-induced stressors such as pollution, may push coral reefs past a tipping point. Climate model predictions of annual bleaching by 2050 are incompatible with the survival of most coral reefs by the end of this century.



Did you know?

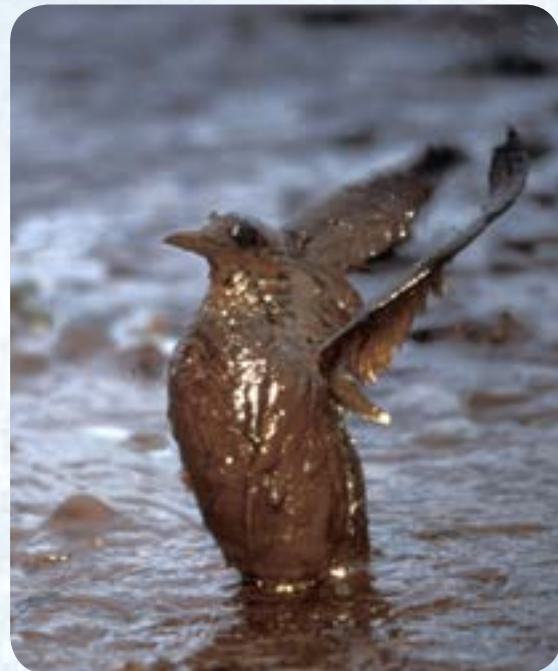
- The ocean is warming and coral reefs are bleaching with increased severity and frequency.
- Climate models predict annual bleaching events by 2050 which will prevent the ability of reefs to recover or adapt.
- The disappearance of coral reefs will have a severe impact on reef fish assemblages with significant declines in the biodiversity and abundance of reef fishes, jeopardising ecosystem function and fisheries productivity.

Good News



Not all coral reefs are equally at risk from climate change

Some reefs are more resistant to the effects of ocean warming while others are located in areas less affected by rising sea temperatures. This leaves the potential for identifying reefs for conservation action and using them to regenerate other, degraded reefs in the future. However, restricting global warming below 2°C is crucial for the survival of coral reefs.



Sources of Pollution in the Ocean

An often quoted statistic is that 80% of all pollution in the ocean originates from land-based activity.

Pollution has had serious impacts on the ocean and the wildlife it supports, interfering with physiology and behaviour and impacting biodiversity. Due to pollution and other stressors including overfishing, marine wildlife is under greater threat than ever before. Some researchers claim that since 1970 there has been a 50% decrease in marine species. The types of pollution impacting the ocean are many and varied including:

Waste (including plastic)

This can include everything from food packaging, to plastic films (carrier bags) and microplastics from the breakdown of larger items. Most waste enters the ocean from rivers, the majority of which are in developing countries. However, there is also a

considerable amount of fishing industry waste. Most waste can technically be recycled but globally there are considerable economic barriers to this happening.

Chemical and agricultural run-off

Industrial and chemical pollutants make their way into water treatment systems, discharge into rivers and then into the ocean. Fertilisers and pesticides, applied to crops, and animal waste can be washed into water courses and out to sea leading to excess of nitrogen. This is linked to 'dead zones' in the ocean and to algal blooms, resulting in oxygen depletion and loss of biodiversity.



Oil spills

When we think of oil in the ocean we assume this has occurred due to a large event, e.g. Deepwater Horizon or the sinking of an oil tanker. In fact much oil pollution in the oceans is due to run-off from land-based sources, the

normal operations of tanker traffic and effluent from oil rigs and other sea-based operations. Some pollution also comes from natural sources such as natural oil seepage.

Untreated sewage and waste water

The sources of untreated and waste water could be both land or water based (from shipping for example), and consists of untreated urine and faeces. This introduces nitrogen and phosphorous into the water, but also microorganisms such as bacteria and viruses, helminths (worms) and a variety of chemicals and oils as well as pharmaceuticals. Anything that has been flushed or disposed of in a drain, including wet wipes, that does not break down easily contributes to this. Sanitary products and oils also cause issues in sewage treatment systems.

What can we do to reduce the impact?

In the UK and throughout most of Europe there is a formalised system of waste collection, transport, treatment and disposal. However, this is not true of all countries where waste collection and treatment can be informal, or even non-existent. However many countries now recognise the issues and are improving waste management practices, investing in infrastructure and formalising waste collection and treatment. These initiatives will significantly reduce the amount of plastic entering the ocean.



Did you know?

- Most ocean pollution begins on land.
- Oil is harmful to wildlife including birds and mammals. It destroys the insulation that fur and feathers normally provide and ingestion can prove toxic.
- Many marine mammals like dolphins and whales rely on communication by sound to find food, mates and to navigate. An increasing barrage of human-generated ocean noise pollution is altering the underwater soundscape and harming marine species.

Good News



Reducing run-off into rivers reduces pollution in the ocean

Greater emphasis on reducing the amount of run-off into rivers, and reduction in use of fertilisers and pesticides and their targeted management is also reducing pollution entering the ocean. It is within our grasp to improve the state of our ocean throughout the world, and public opinion has the power to concentrate the minds of governments as we have seen with single-use plastic within the UK.



Plastic Pollution in the Ocean

Excessive use of short-lived plastic items is causing a serious threat to the health and wellbeing of the ocean.

The creation of synthetic plastic polymers is arguably one of the greatest inventions of the last century. However, this revolutionary material now finds itself depicted as public enemy number one by many people. What are the issues associated with plastic pollution in the ocean? Does the scientific evidence support legislative intervention, the spending of public money on scientific and technological solutions, and justify the overwhelming public support in favour of banning single-use plastic?

The scale of the problem

More than 300 million tonnes (Mt) of plastic is manufactured each year, with an estimated 8,300 Mt of virgin plastic produced to date. Most of this

plastic is derived from fossil fuels and is non-biodegradable and so the only way to truly eliminate or recycle it is by undertaking some form of thermal treatment. The durability of plastic is a highly desirable characteristic for many applications (e.g. medical, packaging, construction), but can lead to unintended consequences if it enters the environment.

It's estimated that there are more than 5 trillion pieces of plastic (270,000 tonnes) in the world's ocean, the majority of which originates from land based environments (80%). Poor waste management practices and infrastructure, particularly in developing



nations, is one of the major reasons why plastic is finding its way into the ocean. However, this is a truly global challenge where industrial practices, consumer behaviour and societal norms in all countries are contributing to the issue. In the ocean the

degradation of plastic is incredibly slow due to, in part, cold temperatures and the filtering out of ultraviolet radiation by water. This longevity means that plastic is found in all parts of the world's ocean, including the most remote and deepest place on the planet, the Mariana Trench.

The potential consequences of plastic pollution

Larger items of plastic are responsible for the physical entanglement and the suffocation of animals. Plastic is also sometimes mistaken as food and if ingested can ultimately lead to starvation.

Plastic particles adsorb and concentrate persistent organic pollutants found in the ocean and may transfer them into food chains, including human food chains.

Various chemical substances (additives, e.g. plasticisers) that enhance polymer properties may leach into the ocean. Interactions with certain chemicals can lead to changes in animal physiology and behaviour, and in some cases cause mortality.

The scientific evidence is clear, the presence of plastic in the world's ocean has negative consequences. The key question is can we do something about this?

What can and should be done?

Solving the issue of plastic pollution in the ocean may seem insurmountable because of the sheer scale of the problem. However, scientists have predicted that if all sources of plastic entering the ocean were stopped, it would only take three years for all plastic to fall to the ocean floor, reducing some of its impacts.

The problem therefore is not like other challenges that might take decades (e.g. ozone layer depletion) or hundreds of thousands of years (climate change) to rectify or reverse. Real observable changes could be made with concerted effort today. Part of this will be societies moving away from take, make and dispose (linear) economies to produce, use and recycle (circular) economies, that produce less plastic waste.

Did you know?

- Assuming no action is taken, it is estimated that the amount of plastic in the ocean will increase threefold by 2025.
- Microplastics (particles of less than 5 mm) are also found in air and scientists are currently unsure of the potential risk this poses.
- In some cases plastic helps protect the environment. For example plastic can help prolong the shelf life of perishable foods, which in turn reduces waste and greenhouse gases.

Good News



Plastic pollution in the ocean could be dramatically reduced

Plastic pollution in the ocean could be dramatically reduced by decisive interventions today. Greater voluntary corporate and personal social responsibility will play a key role here, but bringing in legislative measures (e.g. banning some types of single-use plastic) may also be required. Innovation in manufacturing will also play a crucial role in reducing the environmental impact of plastic.



Academic Excellence

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Our Blue Planet

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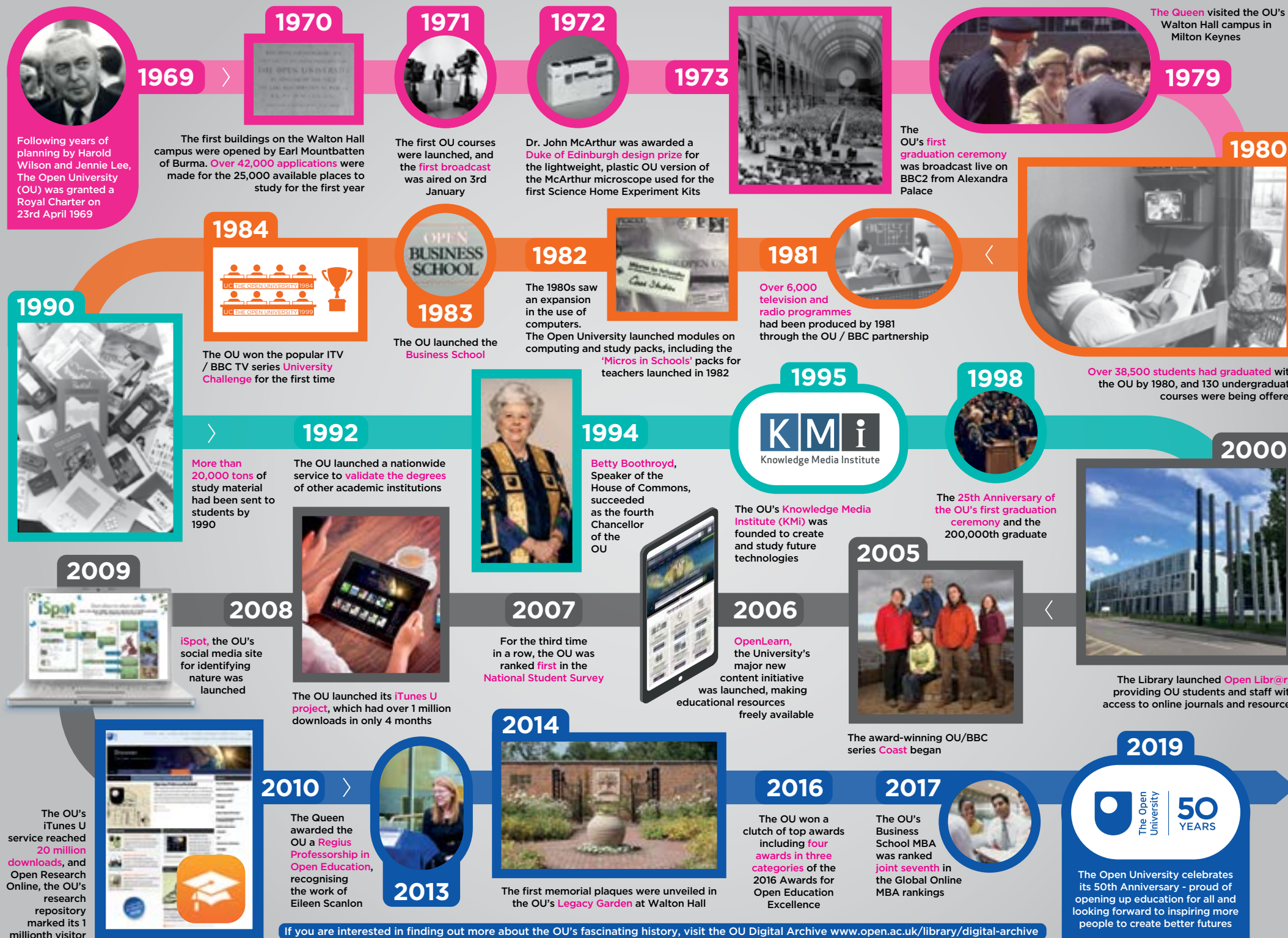
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50 years of inspiration

The Open University was born from a radical idea: to create a 'university that was open to everyone'. After years of planning by Harold Wilson and Jennie Lee, The Open University was granted a Royal Charter on 23 April 1969.

Founded on the firm belief that education should be open to all, the OU has spent the past fifty years helping learners from all over the world to make the impossible possible. As the largest UK academic institution, we are proud to have empowered over two million students across 157 countries to transform their lives through learning.

Technology has always played a key role in allowing OU learners to fulfil their potential anywhere and everywhere. Since the 1970s, The Open University and the BBC have proudly worked in partnership, co-producing award-winning programmes such as Blue Planet and Coast. There have been over 252 million viewings of these joint broadcasts – and counting.

During our landmark 50th birthday, we are building an exciting programme of events and activities that will showcase the students past and present, staff, partners and the OU family who have shaped the OU and make our institution what it is today. As well as reflecting on our history, we are also looking to the future and how we can continue to shape the next 50 years, empowering millions more lives to come.

To learn more and join in the celebrations, visit www.50.open.ac.uk





PETE



HDPE



PVC-U



LDPE



PP



PS



OTHER

Polyethylene Terephthalate

What products is it used in?

Clear bottles (look for 'bubble' on the bottom of a bottle), food trays (clear, green, black etc.).

Can it be recycled?

One of the most commonly recycled plastics, clear bottles are likely to be recycled, remove lids first.

What does it look like?

A tough plastic which discolours if you bend it.

High Density Polyethylene

What products is it used in?

White milk bottles all sizes, bleach type bottles, washing machine liquids and some bottle caps.

Can it be recycled?

Very commonly recycled, remove lids first.

What does it look like?

A thick tough plastic which will spring back if bent, caps can usually be flexed.

Polyvinyl Chloride

What products is it used in?

Clear bottles (look for a line on the bottom of the bottle), food trays, toys, piping, wire insulation.

Can it be recycled?

Rarely recycled, check your local area.

What does it look like?

More fragile and will crack and/or stay bent if stressed, bottles make a 'crinkle' cracking sound if squeezed.

Low Density Polyethylene

What products is it used in?

Plastic bags, plastic wrapping, cling film.

Can it be recycled?

Reuse of bags and targeted collection in supermarkets most likely, dispose of materials contaminated with food.

What does it look like?

Can be very thin to thick, but usually flexible and easily torn.

Polypropylene

What products is it used in?

Butter and margarine tubs, clear fresh soup containers, some bottle caps, glass jar caps.

Can it be recycled?

Not generally recycled, check your local area.

What does it look like?

Will shatter into strips if compressed, caps will usually be too hard to flex.

Polystyrene or Styrofoam

What products is it used in?

Yogurt pots, insulated disposable cups, some trays, parcel packaging.

Can it be recycled?

Not generally recycled, check your local area.

What does it look like?

Will tear or pull apart depending on form.

Polycarbonate, Acrylic, Styrene, Perspex

What products is it used in?

Reading glasses, CDs and DVDs and cases, some electrical connections and wiring, general household plastics.

Can it be recycled?

Reuse of individual items more likely, avoid placing in your recycling unless specifically instructed to do so.

What does it look like?

The majority of these plastics are very tough and are likely to shatter if pressure is applied.

