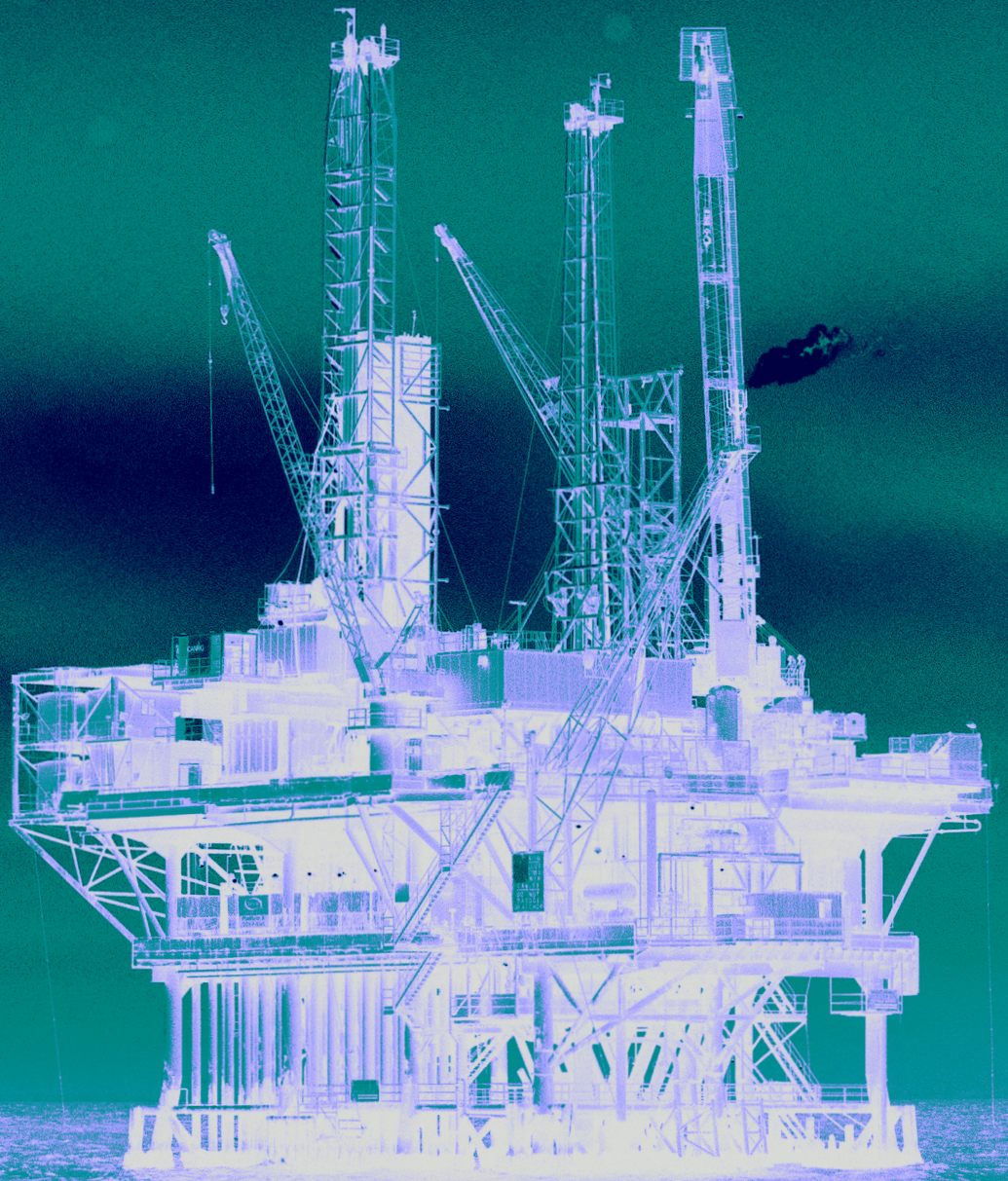
A REPORT BY UPLIFT & OCEANA

In Deep Water



Exposing the hidden impacts of oil and gas on the UK's seas

Uplift

Uplift is a research and campaigning organisation supporting a just transition away from fossil fuels in the UK. Since its establishment in 2021, Uplift has developed leading analysis of the UK's oil and gas sector and the regulatory framework governing the industry. It has also supported campaigns for policy change to align oil and gas production in the UK with its environmental targets. Uplift is the Secretariat for the All-Party Parliamentary Climate Change Group.

Oceana

Oceana is the largest international advocacy organization dedicated solely to ocean conservation. Oceana is rebuilding abundant and biodiverse oceans by winning science-based policies in countries that control one-quarter of the world's wild fish catch. With more than 275 victories that stop overfishing, habitat destruction, oil and plastic pollution, and the killing of threatened species like turtles, whales, and sharks, Oceana's campaigns are delivering results. A restored ocean means that 1 billion people can enjoy a healthy seafood meal every day, forever. Together, we can save the oceans and help feed the world.

Report by
Uplift and Oceana

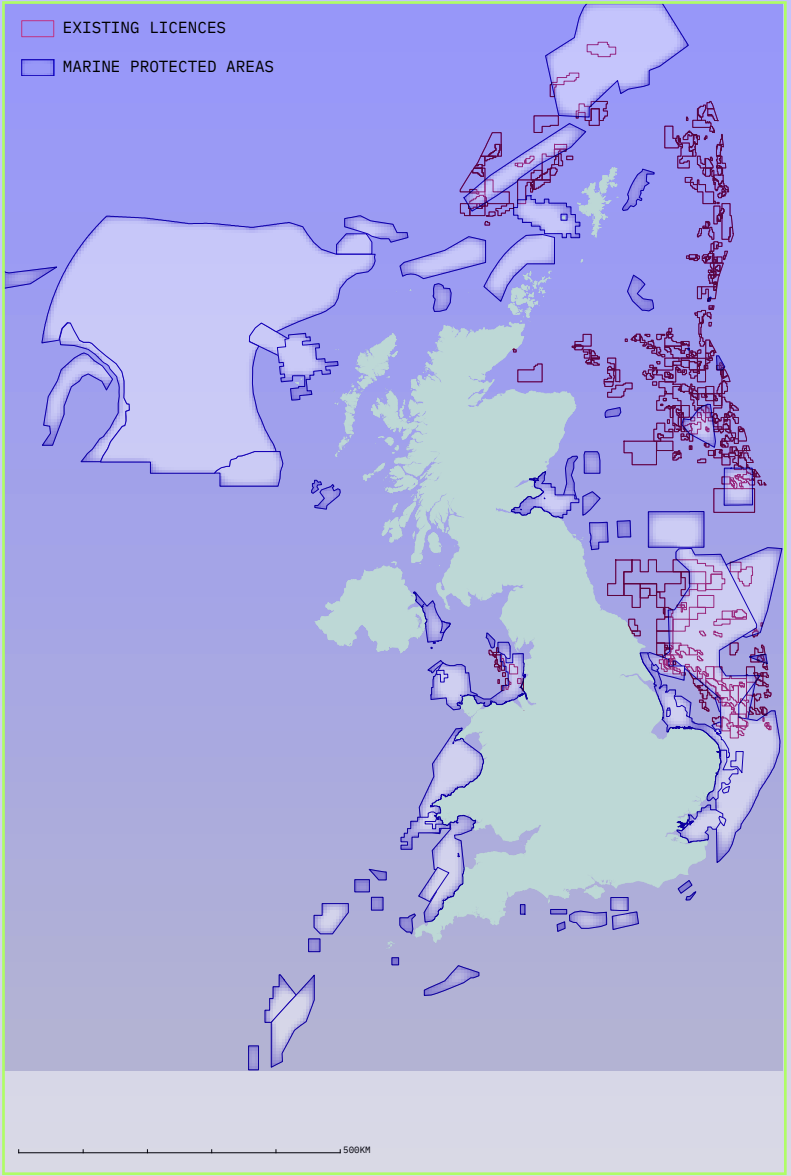
Research by
Dr Fiona Gell, MarFishEco, SkyTruth, the Zoological Society of London, Jasmine Wakefield and Uplift

Maps by
MarFishEco, Zoological Society of London and Uplift.

Design by
Common Knowledge with Shauna Buckley

Proofreading by
Khanya Mabusa

Figure 1. Map of UK's marine protected areas and oil & gas licences



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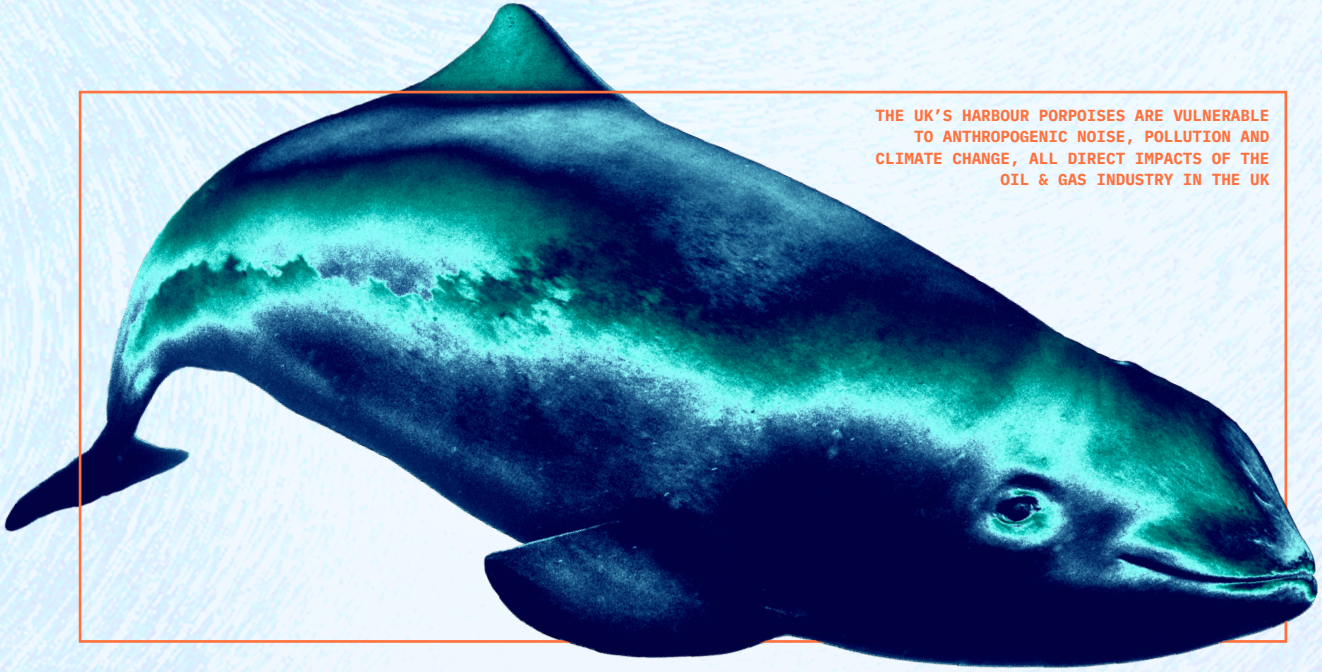
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For five decades, UK oil and gas production in the North Sea has taken place largely out of sight and, therefore, out of mind for all but those directly involved. Little thought has been given to the impact of drilling thousands of wells and developing hundreds of oil and gas fields on the UK's marine environment.



THE UK'S HARBOUR PORPOISES ARE VULNERABLE TO ANTHROPOGENIC NOISE, POLLUTION AND CLIMATE CHANGE, ALL DIRECT IMPACTS OF THE OIL & GAS INDUSTRY IN THE UK

This report looks for the first time at the harm caused by the oil and gas industry on our seas.

It brings together the available scientific evidence, along with the expertise of marine biologists, satellite imagery analysts and many more. The supporting research, including the hundreds of scientific papers and reports that underpin our work, can be found on our website.

As well as presenting the scientific facts, this report also hopes to help spark a renewed interest in, and appreciation for, the UK's seas and the wonderful, diverse creatures that live in them. Our seas are full of life: from the multicoloured sponges and ancient clams that live on the seabed to the schools of fish, mammals – whales, dolphins and porpoises – and seabirds nearer the surface.

The UK's seas, though, have become industrialised, making them too noisy, polluted, built-up, and disturbed for our rich marine life to thrive.

Now is a critical time for the world's seas and oceans. The climate crisis and increased levels of pollution are putting immense strain on marine ecosystems, just as we are beginning to fully grasp the fundamental role they play in regulating our climate by acting as a vast carbon store. This understanding that we need healthy seas and oceans has finally translated into a global target for governments to protect 30% of the global ocean by 2030.

The UK government has created a network of Marine Protected Areas here too which it aims to make safe from damaging human activity such as industrial fishing. But many of these areas are now threatened by proposed new oil and gas developments. This report shows that over a third of new oil and gas licences offered in the most recent licensing round are within or overlap with UK Marine Protected Areas, threatening their ability to protect and restore marine life. When asked, three-quarters of the UK public are opposed to oil and gas developments in protected areas of the sea.

This report, then, is not just a stocktake of the harm that oil and gas drilling does to our seas but also asks us to pause and think: do we continue down this path of industrialisation of our seas, or is now the time to start to protect and restore their wonder.

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Key findings

There are three core areas of concern when it comes to the harm caused by oil and gas developments on our seas.

Pollution from oil, chemicals and noise

Oil and gas development is a major source of pollution in our seas, including oil spills, the release of chemicals and micro-plastics during all phases of production, and a wide range of noise pollution.

Chronic oil pollution, for example, is released in wastewater and in small but routine spills, often unreported or underreported. This can lead to large volumes of oil being released into the sea, including in protected areas. Exploration, drilling, and decommissioning of oil and gas infrastructure also lead to the release of toxic chemicals, including PAHs and mercury, which cause harm to individual creatures across species populations and whole ecosystems. Micro-plastic waste is also released as part of the extraction process, directly polluting the marine environment.

Noise pollution, again created by all stages of oil and gas production, is another major cause of harm, impacting entire ecosystems. In particular, seismic airgun surveys – the loudest and most damaging source of anthropogenic marine noise pollution, which is used almost exclusively in offshore oil and gas exploration – causes severe harm to protected marine mammals, commercially important fish species and invertebrates.

These impacts, plus continuing to license new projects increases the risk of major oil spills, which can have devastating and long-term impacts on marine ecosystems. In the North Sea basin, this risk increases as deeper and less accessible sites are exploited.

Permitting new oil and gas activity in designated protected areas **fundamentally undermines their potential to restore biodiversity**.

Harm to habitats, food chains and the UK's rich marine life

Beyond creating these types of direct pollution in our seas, oil and gas developments are harming some of the UK's precious marine habitats, vital food chains and whole ecosystems.

The UK is home to some extraordinarily biodiverse habitats, such as deep sponge communities, cold water corals, deep sea mud and biogenic reefs. As oil rigs and other infrastructure are built on or near some of these, it is leading to habitat loss, some of which could take decades or more to recover, if at all.

These habitats play an important role in our seas. Deep-sea sponge communities and cold-water corals, for example, cycle nutrients in the ocean. Losing or degrading these habitats jeopardises this crucial function. Oil and gas activity also has multiple negative effects on plankton, the basis of marine food webs, from noise and oil pollution, persistent chemicals and contamination by microplastics.

The impacts of oil and gas developments combine and exacerbate the many other pressures we are putting on our seas, from shipping to fishing, resulting in cumulative impacts that are difficult to measure and mitigate.

Weakening the UK's seas when we need to restore them

Allowing continued investment in new oil and gas developments will mean decades more of these impacts on the UK's marine environment at a time when we need to be investing in restoring our seas.

Permitting new oil and gas activity in designated protected areas fundamentally undermines their potential to restore biodiversity and provide the many other benefits – from supporting sustainable fisheries to protecting our coasts – that we gain from having a thriving marine environment.

UK waters play a critical role too in tackling the climate crisis. Expanding oil and gas production impacts our seas' ability to act as a carbon store both directly, weakening this function by degrading the marine environment and increasing emissions. The continued burning of fossil fuels is having a catastrophic impact on the world's oceans and seas. Unless it is rapidly halted, it will lead to the ecological collapse of many marine ecosystems.

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An appreciation of the UK's seas

Decisions are being made right now that could **significantly alter the prospects for our seas** and the diverse and wonderful species they sustain.

Imagine an ocean where the seabed erupts in flurries of yellow and orange and white sponges, where delicate sea pens sway like elegant feathers in a gentle current, where ancient thick-shelled molluscs, older than many of our cathedrals, record the past like quiet sentinels.

Imagine harbour porpoise, sleek, shiny, and purposeful, gently breaking the surface and surging after shimmering schools of sand eels, streaked with iridescent blue, and flurries of herring glinting silver in the sunlight of the surface waters. Imagine the huge blue bulk of a breaching humpback whale, the flash of white on its pectoral fins, and the gnarled encrusting barnacles around its jaw. Imagine a water column rich with the life-sustaining swirl of phytoplankton. The industry and intent of the zooplankton – small shrimps, fragile-shelled larval molluscs and baby fish – hatching and feeding and settling.

Imagine great schools of copper-tinged cod swimming over a seabed alive with invertebrates; horse mussel reefs forming undulating mounds and oyster reefs with layer upon layer of shells creating homes and habitats for hundreds of species. Gannets diving from above at lightning speeds and surfacing to digest their fishy prey. Storm petrels flying just above the surface and great rafts of guillemots congregating.

These vibrant scenes are not describing a tropical paradise half the world away. They are describing the great, diverse expanse of the North Sea stretching up from the French coast to the Norwegian Sea and from the enclosed waters of the Irish Sea.

These are not muddy wastelands or featureless sands, but rich, productive ecosystems that provide homes to a huge variety of animals and plants and play an essential role in preventing climate breakdown and in supporting the health and well-being of the UK's population.



LION'S MANE JELLYFISH
ABERDEENSHIRE, SCOTLAND, UK

If you look at a map overlaid with the uses of UK waters, it is hard to imagine the richness of the marine ecosystems that remain. The sea appears to be studded with oil rigs and gas platforms, pipelines and cables, and heavy industry. It is crisscrossed with shipping routes and patchworked with fishing grounds.

There are oil spills and a constant trickle of oil from wastewater. The speckled patterns of these dark slicks on the surface can be clearly seen in satellite images. The oil coats seabirds and otters, and is inhaled

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by sei whales and harbour porpoises as they come up to the surface to breathe. It coagulates into tar balls or disperses into tiny droplets, which sink and take the pollution to the rich benthic habitats beneath – the horse mussel reefs, cold-water corals, and delicate sponge forests.

Toxic chemicals and microplastics slowly disperse away from the oil and gas rigs where they have been discarded and are gradually ingested by the worms and shrimps and small bivalves at the bottom of the food chain, making their way up through the sand eels and snails to the dolphins and whales. Historic pollution is unearthed from the seabed sediments around old oil and gas rigs, disturbed by new developments or natural activities.

And the noise is incessant. The deep boom of seismic surveys, always underway somewhere, travelling for hundreds of kilometres; the judder of enormous ship engines; the blasts of construction; the whine of drilling to extract resources from beneath the seabed.

At the same time, as we continue to burn fossil fuels, the seas are getting warmer, disrupting the seasons and cycles on which marine ecosystems depend and forcing the more northern species in UK waters to retreat into colder waters. Marine heatwaves are becoming more frequent, devastating corals and other temperature-sensitive marine life. Rising carbon dioxide in the atmosphere is also changing ocean chemistry, depleting essential dissolved oxygen, acidifying the sea, and causing shelled creatures to lay down thin and inadequate shells.

The UK's waters are now networked with Marine Protected Areas (MPA), and there are new Highly Protected Marine Areas (HPMA) to come. Well-protected MPAs enhance biodiversity within their boundaries and beyond, boost fisheries and support the restoration of healthy, effectively functioning ecosystems. This in turn, helps the ocean provide its vital climate regulating services and can boost the capacity of marine habitats and species to lock down carbon that would otherwise be contributing to carbon dioxide in the atmosphere.

The protection of the UK's existing MPAs is patchy, ranging from a tiny number of no-take fishing zones to large, designated areas with limited protection in place, but this is improving. Restoration projects are underway to rebuild the lush seagrass meadows, resplendent oyster banks and biodiverse horse mussel reefs that we have lost. Our seas are being reshaped for a new future and their importance in supporting effective climate action is increasingly acknowledged. But a large proportion of these sites are at risk from current and potential new oil and gas within their boundaries, very close by or within the radius of influence of pollution, noise, and other impacts.

One single action could vastly improve the health of the UK's precious seas and the bounty they bring us: ceasing new oil and gas developments. As existing oil and gas installations reach the end of their lifetime and are appropriately decommissioned, they will be to some extent replaced by offshore wind farms. These offshore renewables are essential for our carbon-free future and, whilst their less significant impacts must be mitigated,[1] they do not have the high-intensity seismic noise, the routine chemical pollution, the oil spill risks or the toxic legacy of oil and gas.[2] Nor, of course, the climate impacts.

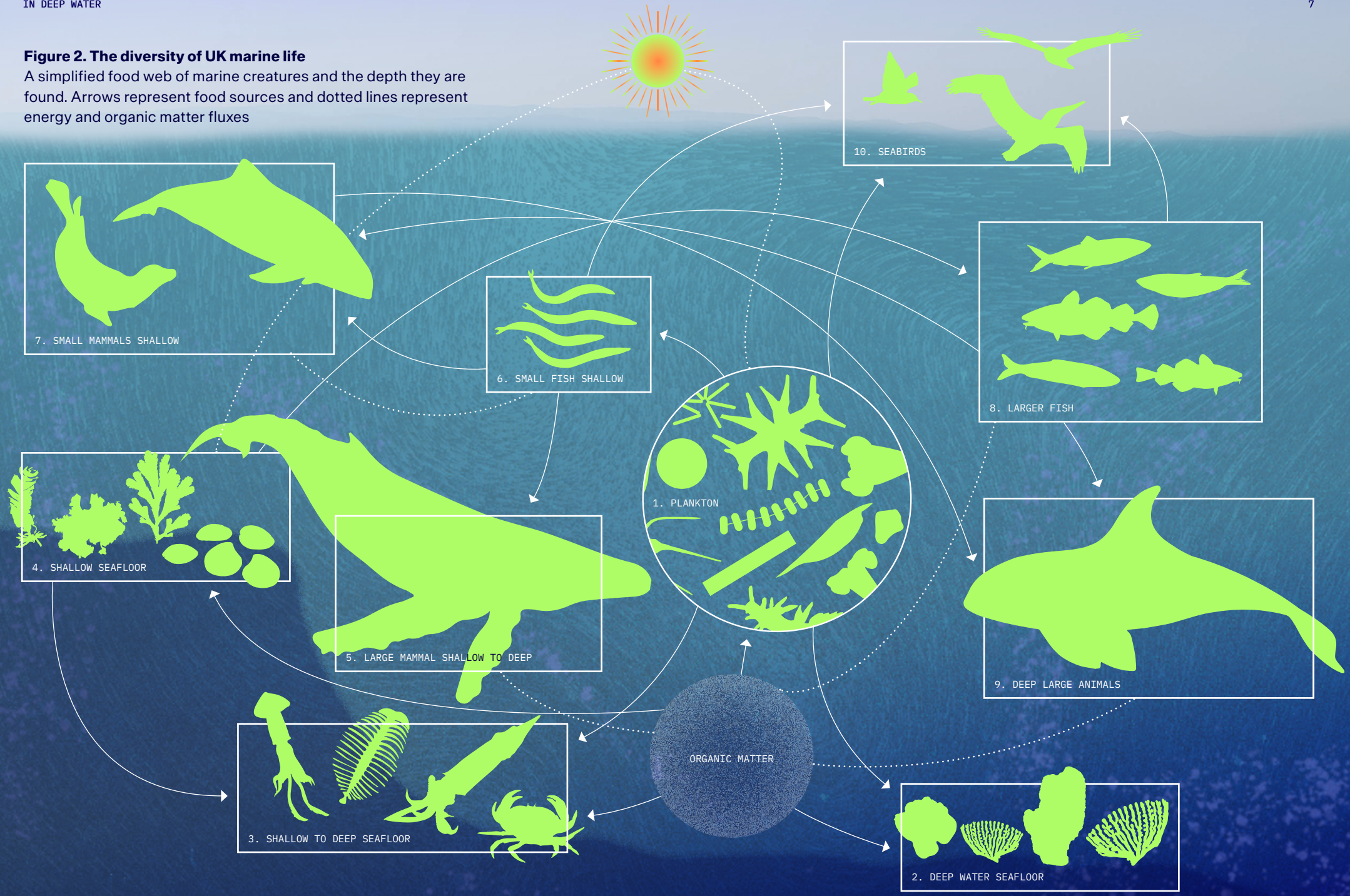
If the UK government stopped approving new oil and gas developments, the benefits to our wonderful sea life will be endless. Most obviously, it would help the UK deliver its essential emissions reduction targets, which would help reduce the multiple impacts of climate change on the ocean. But the wider ecosystem benefits could be game-changing for UK marine conservation too.

This report outlines how continuing to approve new oil and gas is contributing in a major way to the myriad problems facing the UK's seas, just at the time when we need our marine ecosystems to be as healthy as possible.

The government can **end the fossil fuel industrialisation of our beautiful, bountiful seas**, starting with a cessation of new oil and gas projects.

Then together, we must build a vision for our maritime area for the 21st century where marine ecosystems are brimming with biodiversity and where the wealth of benefits they bring to people and the planet are our top priority.

Figure 2. The diversity of UK marine life
A simplified food web of marine creatures and the depth they are found. Arrows represent food sources and dotted lines represent energy and organic matter fluxes



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In the current climate emergency, the advice on new fossil fuel extraction is clear; most of the planet's fossil fuel reserves must stay in the ground to have any chance of meeting the climate targets required to restrict temperature increases to 1.5 °C.[3]

Our understanding of the ocean's role in climate change mitigation and adaptation is increasing, but a rapidly degrading ocean has less capacity to continue in this role.

Our global efforts should focus on reducing the need for fossil fuels through improved energy efficiency, eliminating waste, and investing in renewable energy alternatives. The climate change case for this transition is clear and uncontroversial and has been the position of the International Energy Agency since 2021.[4] This stance is increasingly being committed to by a growing number of countries in the Beyond Oil and Gas Alliance, which are following up on ambitious emissions reduction commitments with the necessary move away from the extraction of fossil fuels.


OIL SPILL CLEAN-UP

The UK has a laudable and ambitious series of legally binding emissions reduction targets to reduce emissions by 68% by 2030, 78% by 2035 and net zero by 2050 that were heralded as world-leading when they were announced in 2021.[5] Recent policy changes, however, have seen an increasing commitment to continuing to support, facilitate and even incentivise new offshore fossil fuel developments, which risks undermining the UK's international obligations, including those made under the Paris Agreement,[6] and the UK's previous position as a climate leader.

For over 30 years leading offshore oil and gas companies have built their businesses and lobbied against climate action with the knowledge of the impacts of the global temperature rises they were causing.[7,8] It is now known that scientists at Exxon, for example, had the same level of understanding of the seriousness of the climate change impacts of fossil fuel use as government scientists and academics. However, they actively worked to cover up this evidence and lobby strongly against government climate initiatives despite that knowledge[7] ExxonMobil continues to extract oil and gas from over 40 sites in the North Sea.[9]

The marine environment has come increasingly under pressure in the past century, and these harmful impacts have accelerated in the past decade,[10] reducing its capacity to deliver ecosystem 'services',[11] from fisheries to coastal protection, water quality to climate regulation.[12,11] Ocean ecosystems have so far provided a buffer for the impacts of rising greenhouse gases in the atmosphere, absorbing a large proportion of the additional carbon dioxide produced.[13] Marine ecosystems have also helped us adapt to the already visible impacts of climate change by protecting our coasts from erosion,[14,15] providing lower carbon food sources[16,17] and protecting communities from increasingly extreme weather conditions.[18] Our understanding of the ocean's role in climate change mitigation and adaptation is increasing[19-21] but a rapidly degrading ocean has less capacity to continue in this role.

There is a common misperception that British seas, particularly our offshore environment, are boring, featureless, and bland, however, this could not be further from the truth. From cold-water coral reefs to fin whales, our seas are rich, productive, and worth protecting. What happens in these offshore areas is often invisible from shore and challenging to monitor and measure, but it is essential that the marine ecosystems are well-managed and protected from harm.

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The impact of offshore oil and gas on the UK's marine environment



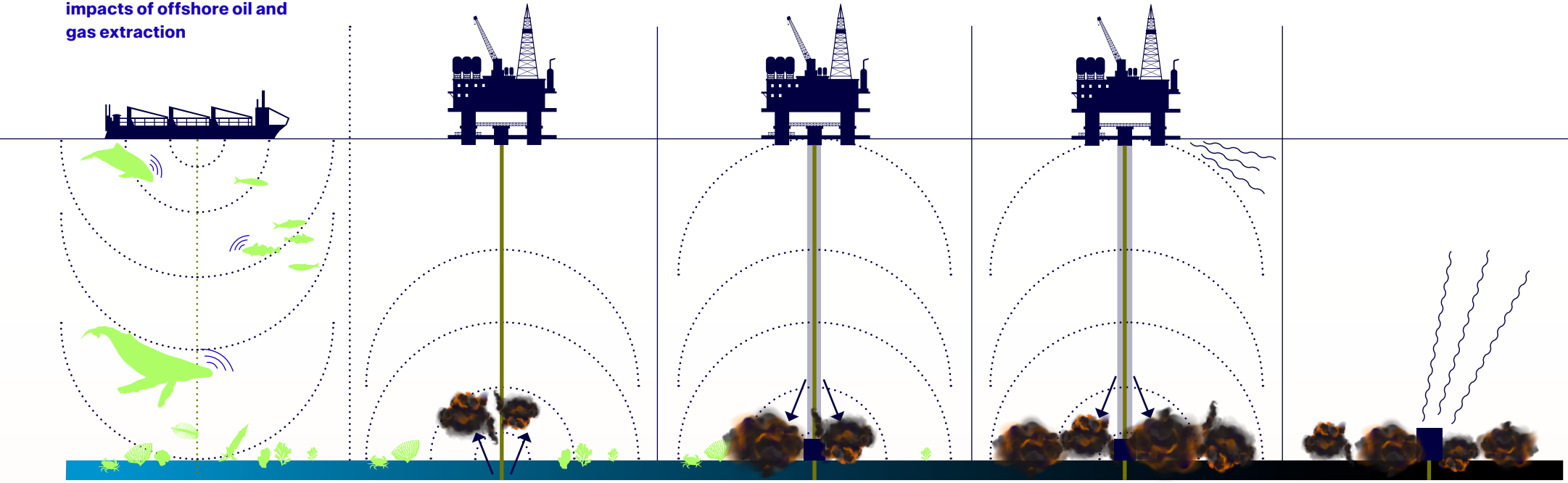
There are a whole series of phases in the offshore oil and gas industry, from exploration to production and decommissioning of an oil rig or gas platform.[2] Extraction rigs and other installations are usually designed to operate for 15-30 years but are often used for longer.[23] Extraction can continue for over 30 years, so projects approved now may still be producing fossil fuels after the UK's 2050 net zero target.[5] The projects without an exploration licence and not yet built certainly will be.

Each stage has a different set of impacts on the marine environment, and each new licence represents a long-term series of consequences for the health of our seas.[2]

Some of the impacts of offshore oil and gas are more apparent than others. The construction of infrastructure like oil rigs and gas platforms modify the seabed,[24] building pipelines and refineries to bring oil and gas to shore impacts on coastal habitats and catastrophic oil spills risk killing seabirds[25] and oiling miles of coastline, with dispersal attempts causing additional damage.[26]

However, many more impacts are much less obvious but nonetheless are degrading our marine ecosystems and contributing to global emissions. Leaking installations and intentional flaring of gas, for example, result in significant methane emissions, the most potent greenhouse gas, which are not usually properly accounted for in the national emissions inventory.[27] Oil and gas developments in UK waters are also affecting every link in the food chain and, because of this, affect the essential services and wider benefits that we rely on the ocean to supply.[28]

Figure 3. The development stages and associated impacts of offshore oil and gas extraction



6 YEARS

EXPLORATION

Seismic and other surveys to determine geological structure of sub-surface and sea-surface
Seismic surveys cause multiple negative effects on sea creatures. These impacts include, but are not limited to, sound avoidance, stress, hearing loss, interference with communication and death.

EXPLORATION

First exploratory wells
Marine noise, seabed disturbance and habitat loss, drill cuttings disposed on seabed.

4 YEARS

APPRAISAL

To determine economic feasibility
The drilling of exploratory wells causes marine noise, seabed disturbance and habitat loss. Drill cuttings disposed on the seabed smother benthic habitats.

15-30 YEARS

DEVELOPMENT & PRODUCTION

Drilling of wells & pipe laying
These activities create seabed disturbance and habitat loss, smothering creatures like sponges and corals. Drilling also creates marine noise and releases pollutants.

Extraction of oil and gas
Flaring (burning gas) and venting (direct release) emit greenhouse gases. Produced water containing oil and chemical pollutants can be released, contributing to chronic oil pollution (see images on page 12). Other pollution sources include the disposal of sewage water and drains.

MAY TAKE DECADES OR NEVER RECOVER

ABANDONMENT

Well plugging with cement
There is a risk of oil and gas leaks if not plugged correctly.

Structure cut below surface and left in place or installations are demolished
If demolished artificial reefs are removed and destroyed. Long buried toxic chemicals can be released as sediments are disturbed. Naturally occurring radioactive materials from petroleum reserves can build-up in pipes, which can then be released.

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2.1 Pollution

Pollution is the most widely researched and accounted for impact of the offshore oil industry. Catastrophic spills like the Exxon Valdez in 1989 in Alaska, the Braer in the Shetland Isles in 1993 or BP's Deep Water Horizon event in the Gulf of Mexico in 2010 demonstrated the immediate wildlife disasters associated with big oil spills[29–31] as well as the great depths and vast areas over which severe impacts were experienced.[32] Subsequent monitoring and research have also shown the less visible and long-term impacts on coastal and ocean ecosystems[33–35] and demonstrated the toxic legacy that remains decades after a big spill.[33,35]

The probability of a major oil spill in UK waters is relatively low,[28] however, the risks associated with a major spill if it did occur are tremendous and as oil extraction moves into deeper, more challenging sites, the risk of spills increases. Additionally, it is more challenging to respond to a major deepwater spill and to properly document the marine environmental impacts.[37] A recent study found the number of reported incidents (blowouts, oil spills, injuries etc.) at platforms was correlated with depth and that for every additional 100 feet of depth, there was an 8.5% increase in the probability of a reported incident.[36] There are also indications that while oil spills from tankers have decreased in frequency, deepwater blow-outs and pipeline issues have become more common.[38] This is particularly concerning given the major proposed new oil developments in deep water West of Shetland: Rosebank, Cambo and Clair South.

It is a long time since the UK has seen a major oil spill, and that has led to some level of complacency about the risks and consequences if we were to have one. When 72,000 tonnes of crude oil spilt from the Sea Empress off the Welsh coast in 1996, there were wide-ranging impacts on coastal habitats, including saltmarsh[39] and major impacts on seabird populations that lasted for years after the event.[40] Three years earlier, the Braer oil tanker ran aground in Shetland releasing over 84,000 litres of light crude oil. This resulted in elevated levels of polycyclic aromatic hydrocarbons - or PAHs – in fish and shellfish,[41] oiling of sea otters[42] and respiratory illnesses in grey seals.[43] It also had major impacts on local fisheries, with fishing excluded within 400 miles of the spill and reported impacts on herring spawning and scallop fisheries.[44]

If a major deep-sea blowout of an oil well were to occur in the proposed Rosebank oilfield, depending on the conditions, it could result in a series of catastrophic impact. It would affect the fragile, deep water coral habitats and ocean quahog aggregations within the site, horse mussel reefs and herring spawning grounds further afield, as well as seabirds, sea otters' resident in coastal waters and migrating fin whales and sei whales.

Modelling shows that a major oil spill from Rosebank could risk serious impact to at least 16 UK Marine Protected Areas.

Oil spills harm marine mammals in many ways, for example, through direct contact with oil when swimming, swallowing oil when feeding in contaminated areas or on oiled prey, or through inhaling toxic vapours at the surface. Some marine mammals may die immediately from oil spills, and there is evidence from many species for longer-term health issues and on the number of young they produce, affecting populations and whole ecosystems.[35] Major oil spill incidents in the Shetland Islands,[46] for instance, including the Braer oil spill[42] led to deaths and long-term population changes among European otters.

Long-term impacts on fisheries can also be significant. The BP Deepwater Horizon oil spill took place during a key time for fish spawning. It was estimated to have resulted in the direct death of between 2 and 5 trillion fish larvae in the area – leading to long-term production losses.[47] In the UK and USA, high PAH levels have been found in seafood following major oil spill events, putting consumers at risk as well as fish and shellfish.[48]

Oil contamination also causes cardiac arrest and high levels of mortality in blue mussels and horse mussels,[49] two key reef-building species that create productive biodiversity hotspots in UK waters.[50] Chemicals are often used to help disperse the oil, and while these may address some of the more visible impacts of oil spills, for example, the oiled birds and the impact on seals and other marine mammals, they can be damaging to other species, including cold-water corals[51,52] and spawning fish.[31]

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Major accidental oil spills and blowouts are not, though, the main source of oil contamination in UK seas. The vast majority comes from something called *produced water*. This is the water that is extracted from deposits along with oil as part of the production process. It has been identified by the OSPAR Commission, which is the international body overseeing protection and offshore activities in the Northeast Atlantic, as accounting for 95-99% of all reported oil discharges to the region's waters between 2009 and 2018 (except for 2011-12 when a large oil spill accounted for 11-12%).[53,54] There are fifteen governments under OSPAR, and due to a higher proportion of older and less efficient installations,[53] the UK was identified as having the highest concentration of oil in produced waters in all of OSPAR's fifteen governments.

Chronic oiling is the ongoing release of smaller, everyday oil slicks, mainly from anthropogenic sources,[55] and produced water is a major source of chronic oiling, which is still prevalent in offshore areas. Some of these releases are reported, and data is available on the size and location of the release. Others are not reported but are large enough to be picked up by satellite imagery. The oil released from these spills has the same potential to kill seabirds[56,57] and sea life and to significantly impact the life chances and reproductive success of others.

This chronic oiling is going on under the radar but with a potentially enormous cumulative effect, adding significantly to the overall impact of the industry. Research from Skytruth and Uplift using satellite imagery and artificial intelligence has revealed the extent of North Sea chronic oiling, and its geographical spread is extensive, representing large volumes of oil (Figure 4).

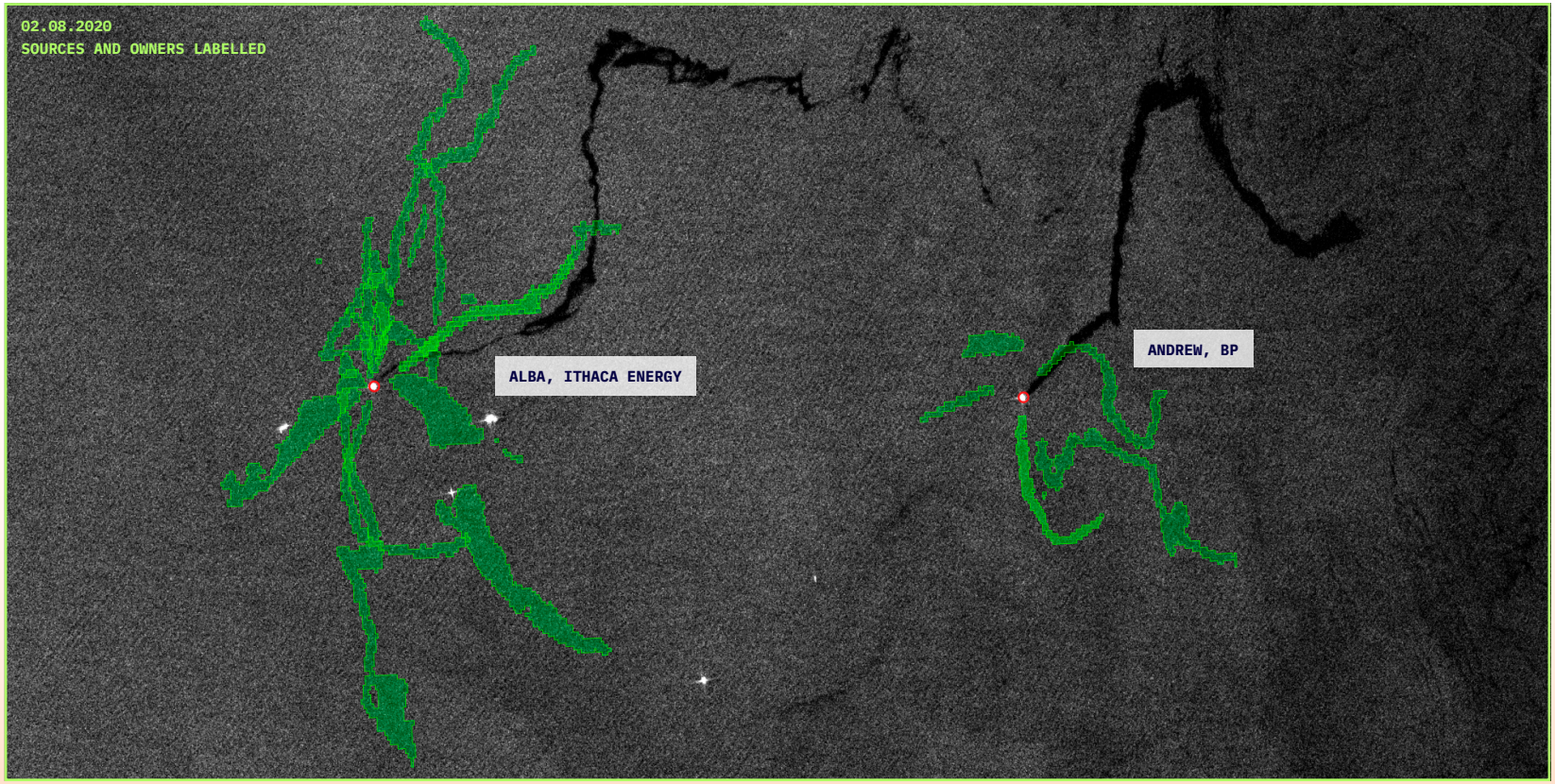


Figure 4. European Space Agency Sentinel-1 satellite image showing two ~20 km long oil discharges 210 km North-East of Aberdeen. The green shapes show other slicks detected by SkyTruth's AI-powered Cerulean system over a two-year period from the same rigs.

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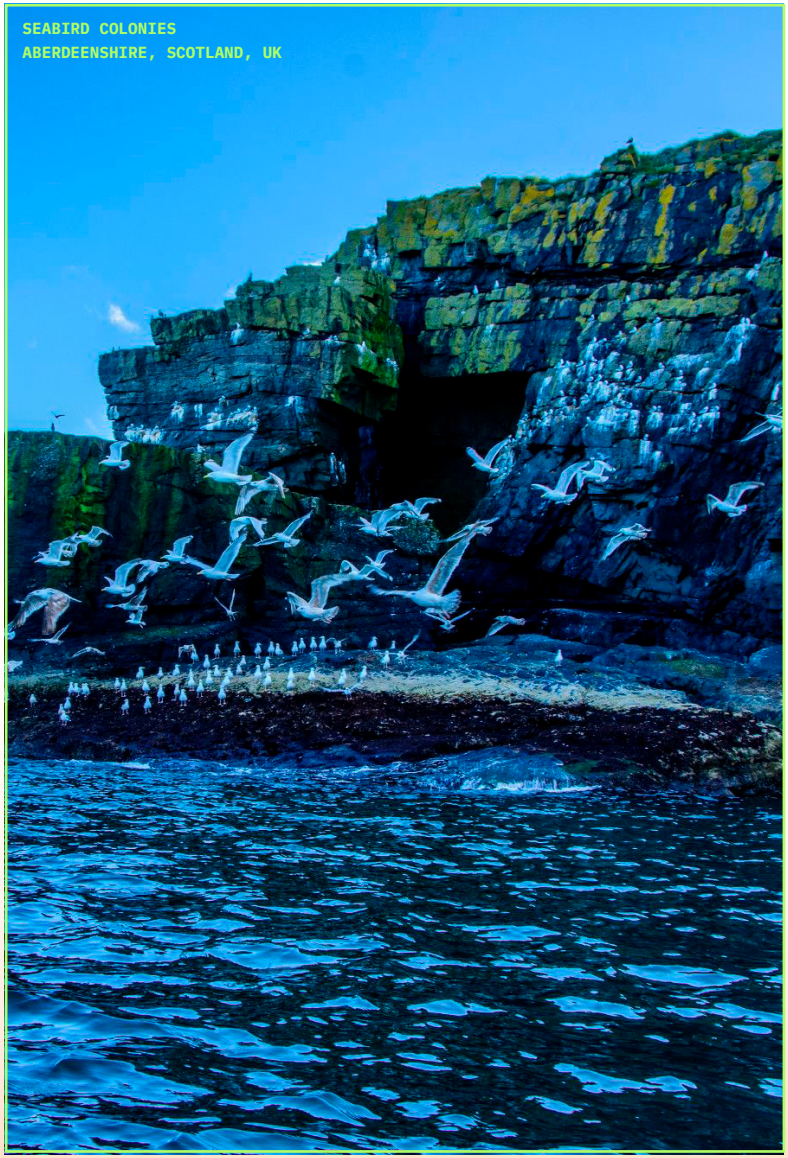
Whales, dolphins and seabirds, and some of our most endangered species and habitats are subject to a constant flow of small oil spills, which, added together represent an enormous source of pollution.

In addition to oil, other pollutants are associated with produced water, including toxic chemicals added to the drilling process.[58] These chemicals are generally expected to be present in high enough concentrations to impact marine life within an area up to a kilometre from drilling activities.[59,60] They have also been shown, in both field studies and laboratory experiments, to cause skeletal deformities in haddock,[61] permanent changes to genetic material and cancer-causing changes to DNA,[62] reduced filtration rates in bivalves[60] and reduced growth and survival in other marine species.[24]

Polyacrylamide (PAM), for example, is commonly used in oil extraction and found in high concentrations in waste water.[68] It persists in the environment and can also degrade into highly toxic and carcinogenic acrylamide, which can impact ecosystems and has also been found in seafood.[69]

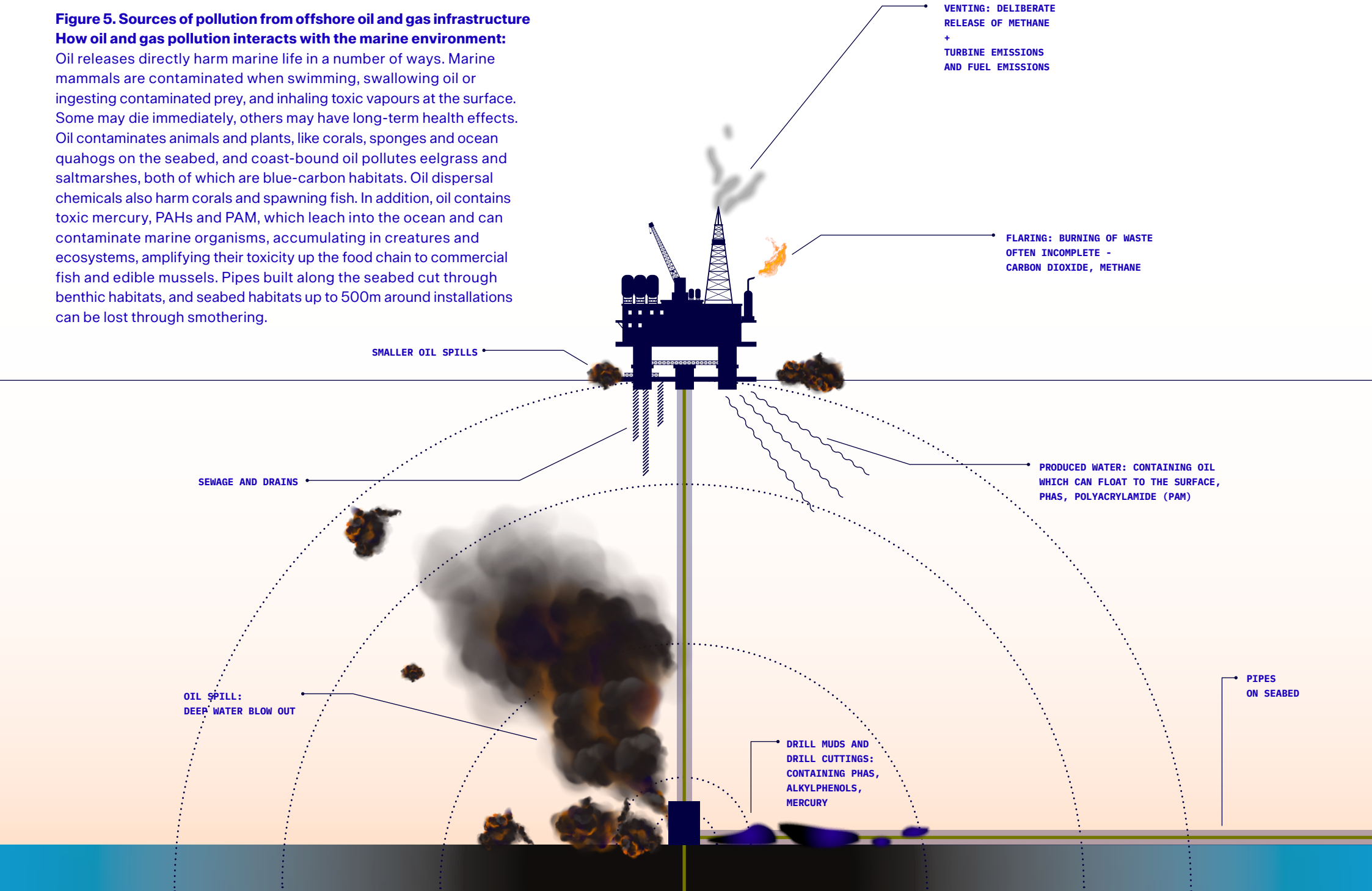
Other processes involved in oil and gas production also introduce chemical pollutants. Contaminants are present, for example, in drill cuttings, fragments of solid material that are removed from a well during the drilling process, and in drill muds, which are used to lubricate the well during the drilling process. The contaminants in these materials, including alkylphenols and PAHs, are toxic to marine life[60] causing defects in developing foetus, permanent and transmissible changes in genetic material and cancers.[63,64] PAHs also accumulate in individuals and ecosystems, amplifying their toxicity higher up the food chain. To illustrate, accumulation of PAHs has been recorded in blue mussels even at low concentrations,[65] and contaminants found in waste material associated with drilling can adversely impact lobsters, affecting the growth, development, respiration and feeding rates of lobster larvae.[66]

Mercury, one of the most toxic metals, is also present in fossil fuel reserves; when infrastructure is decommissioned it is released into the environment in the waste produced during extraction. Mercury builds up through the food chain with documented toxic effects on marine animals and humans via seafood.[67]



SEABIRD COLONIES
ABERDEENSHIRE, SCOTLAND, UK

Figure 5. Sources of pollution from offshore oil and gas infrastructure
How oil and gas pollution interacts with the marine environment:
Oil releases directly harm marine life in a number of ways. Marine mammals are contaminated when swimming, swallowing oil or ingesting contaminated prey, and inhaling toxic vapours at the surface. Some may die immediately, others may have long-term health effects. Oil contaminates animals and plants, like corals, sponges and ocean quahogs on the seabed, and coast-bound oil pollutes eelgrass and saltmarshes, both of which are blue-carbon habitats. Oil dispersal chemicals also harm corals and spawning fish. In addition, oil contains toxic mercury, PAHs and PAM, which leach into the ocean and can contaminate marine organisms, accumulating in creatures and ecosystems, amplifying their toxicity up the food chain to commercial fish and edible mussels. Pipes built along the seabed cut through benthic habitats, and seabed habitats up to 500m around installations can be lost through smothering.



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Harbour Porpoises

While harbour porpoises are the most abundant species of cetacean in UK waters[248] and populations are thought to be stable,[249] this species is highly endangered elsewhere[250] and is very vulnerable to disturbance, pollution, and loss of food sources.

Oil and gas activities are a major contributor to the cumulative impacts on these small, energetic creatures, potentially leading them to starvation as they divert energy into responding to disturbances. Harbour porpoises are under additional pressure from pollutants,[251] many originating from the oil and gas industry,[252] that bioaccumulate and can also be passed onto young in their mothers' milk.[253]

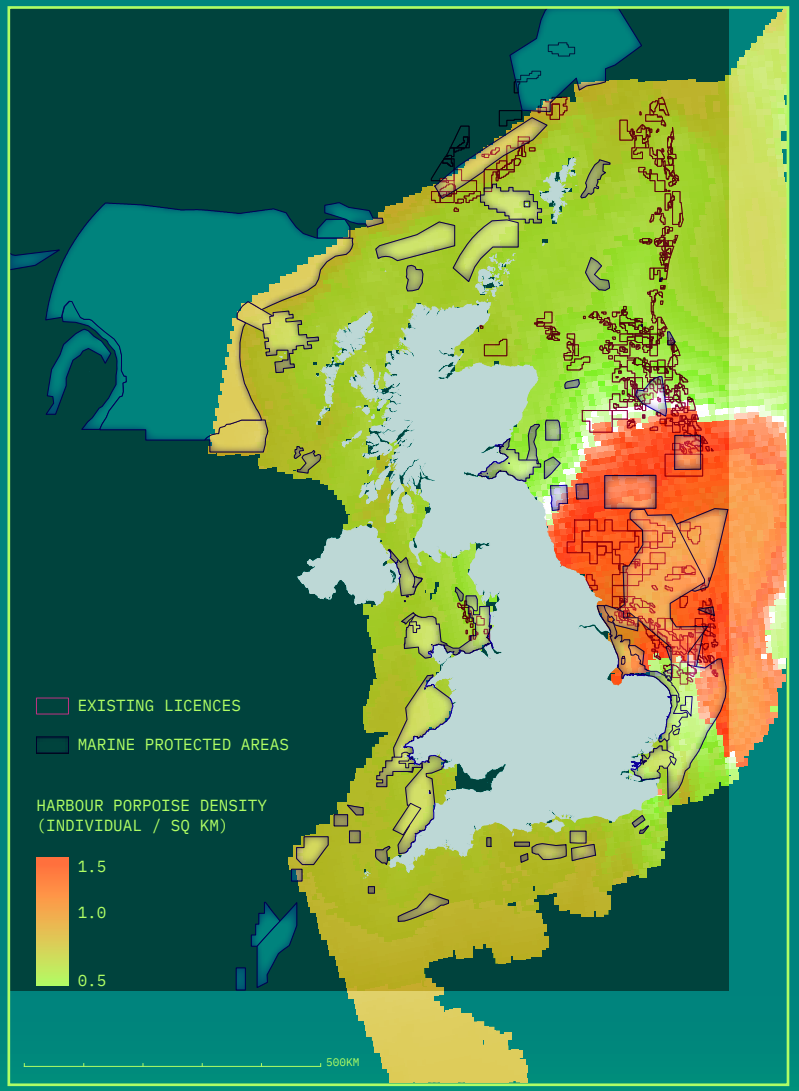
Seismic surveys in Scotland led to significant changes in harbour porpoise behaviour up to 25km from the survey[89] and construction noise led to porpoises moving up to 20km out of an area to avoid the disturbance.[254] Survey and construction noise has been shown to reduce porpoises' capacity to detect prey effectively. A recent study of the impact of the construction of a new gas platform on the Dogger Bank showed major changes in the numbers and activity of porpoises that continued for months.[255]

Oil slicks on the surface also pose a serious challenge to porpoises as they must return to the surface every 5 minutes or so to breathe. Their blow holes can easily become contaminated with oil, toxic vapours, and other pollutants from the surface.[231] Their behaviour can also exacerbate pollution impacts because they may not move from their feeding ground and can continue to feed in highly polluted areas and ingest polluted prey.[256] They can also experience further disturbance from oil spill clean-up activities and toxic effects from substances used to disperse oil.[257]

Even in the absence of a big spill, porpoises experience negative impacts from the chemicals used in the drilling process and are also released from historic activity when sites are decommissioned or otherwise disturbed. Studies have found that PCBs (now banned but previously widely used in offshore oil and gas and still being released from developments) are very likely to be passed to harbour porpoise calves as they feed from their mothers.[253] The combination of contaminants passed to the calves were particularly potent as neurotoxins and likely to impact on the development of the juveniles.[258]

Because harbour porpoises are numerous and have an important ecological role,[259] these multiple impacts do not just affect this fascinating creature but create a cascading effect on the whole ecosystem.

Figure 6. Overlay of harbour porpoise densities, SACs and oil and gas current and proposed sites



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2.2 Habitat Loss

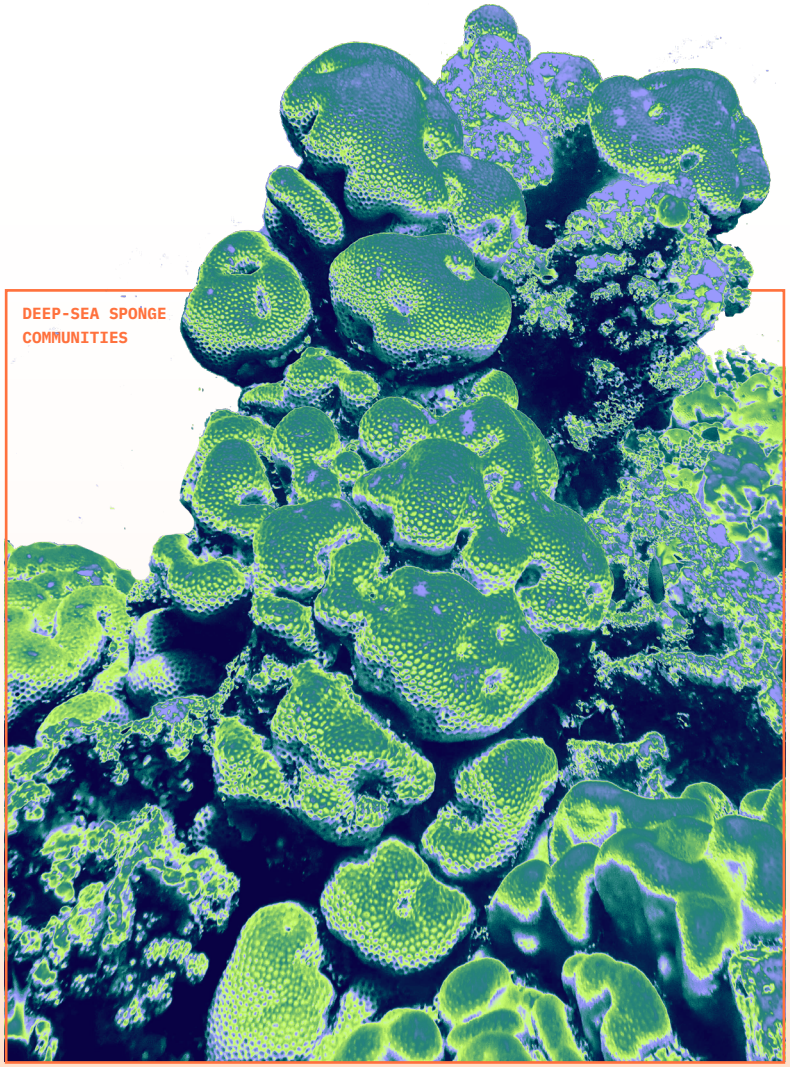
When oil rigs, gas platforms and their associated pipelines, cables and other infrastructure are built they cause direct habitat loss.[28] Many offshore installations, such as mobile offshore drilling units, can also be anchored to the seabed, resulting in areas of habitat loss and risk of further damage, i.e., if the anchors begin to drag during severe storms.[70]

As the area lost to these structures appear relatively small, it has often been disregarded by developers and regulators. But habitat loss still occurs and is not confined to the immediate footprint of development but can extend at least 500 metres from the installation.[71] This happens because construction and drilling create sedimentation,[72] displacing mud and sand, which can form thick layers on the surrounding seabed. This sedimentation can smother habitat-building sea creatures and lead to the complete loss or major degradation of habitats.[22] Habitat loss also happens due to pollution. Oil pollution, for instance, can lead to large-scale and long-term habitat loss, and drill cuttings and other chemical pollutants can impact habitat-building organisms like mussels, degrading the diverse habitats they create.

Habitat loss due to oil and gas infrastructure is always significant but is of special concern when it impacts Marine Protected Areas, rare habitats or species, or vulnerable marine ecosystems. The deep sponge communities of the Faroe-Shetland Sponge Belt MPA are a case in point. This habitat is currently assessed as in unfavourable condition[73] – the technical term for its conservation objection objectives not being met– and efforts should be underway to recover it. Yet hydrocarbon exploration and extraction are already underway, and further sites are currently being made available in areas of this habitat or nearby, including the huge Rosebank and Cambo oil fields.

Both fields would require pipelines and other infrastructure in the MPA, putting the sponge communities at risk. There is already clear evidence of the complete loss of some sponge habitats and lack of recovery after drilling in the Laggan Field, which is in the middle of the protected area.[74]

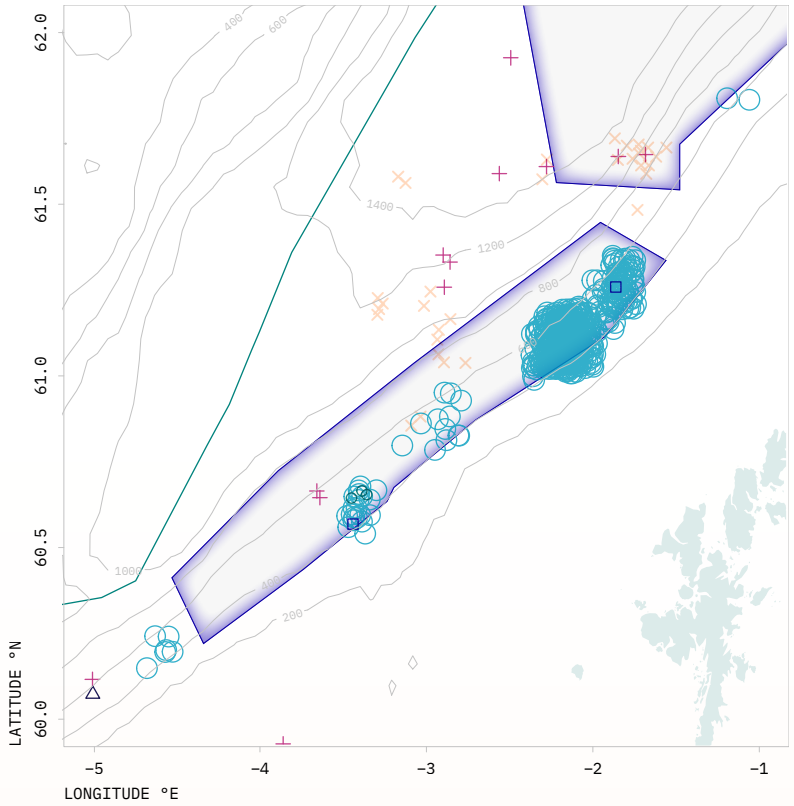
The Rosebank and Cambo oil fields would require pipelines and other infrastructure in the Marine Protected Area, putting the sponge communities at risk.



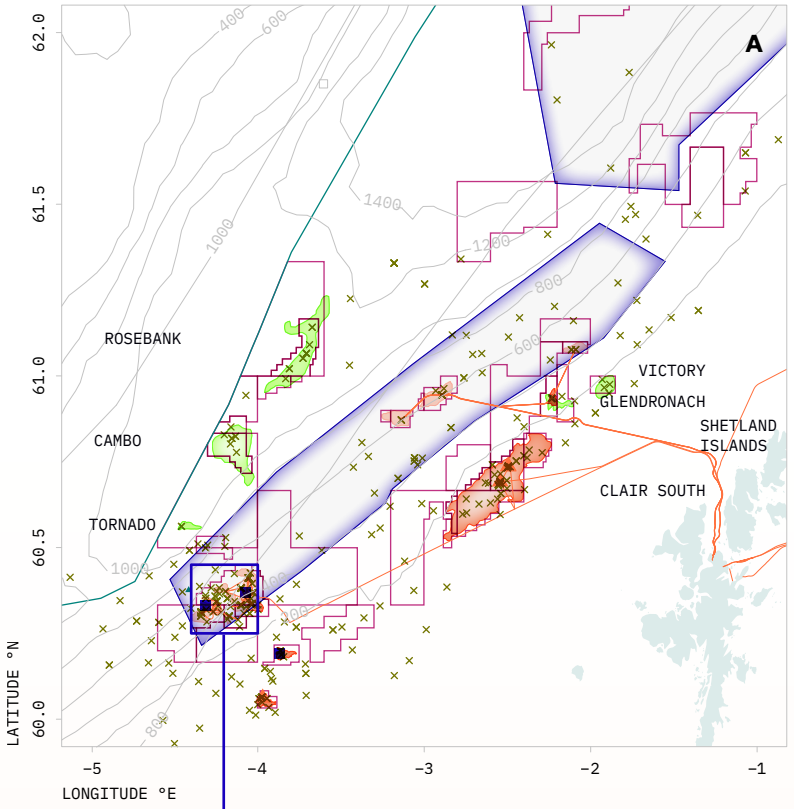
DEEP-SEA SPONGE COMMUNITIES

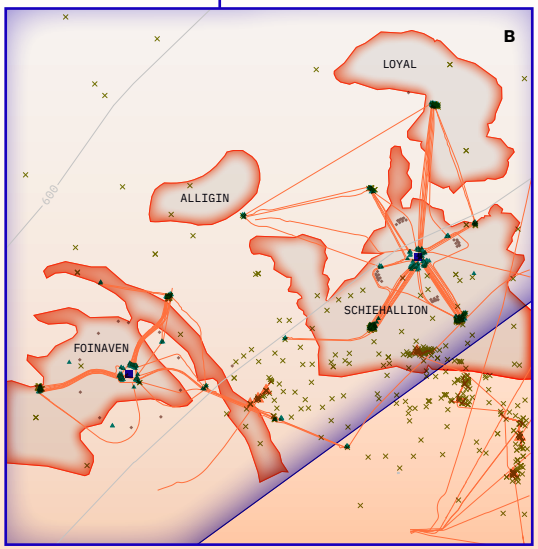
Figure 7. Overlap between protected marine areas and oil and gas drilling

- EEZ (EXCLUSIVE ECONOMIC ZONE)
- MPA
- DEEP-SEA SPONGE AGGREGATIONS
- ANEMONES
- CUP CORAL
- GORGONIAN (SEA WHIP AND SEA FAN CORALS)
- SEA-PEN
- SOFT CORAL
- LICENSE
- PIPE
- FIELDS
- NEW FIELDS
- FPSO (FLOATING PRODUCTION STORAGE AND OFFLOADING)
- PLATFORM
- WELL
- ANCHOR
- SUB-SEA INFRASTRUCTURE



ABOVE
Deep sea sponge aggregations in the Faroe Shetland sponge belt.





ABOVE
Map showing the Cambo, Rosebank and other oil and gas fields west of Shetland and their overlap with the Faroe-Shetland sponge belt marine protected area.

LEFT
Detail of producing fields and their infrastructure in the Faroe Shetland sponge belt.

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2.3 Noise

The offshore oil and gas industries are a major source of ocean noise,[75] the impacts of which are often downplayed or underestimated but have serious impacts on UK ecosystems.

A building cacophony of marine noise (dubbed the "anthropophony")[76] from the thrum of boat engines through to underwater explosions, hugely impacts marine life.[77] Similar to other marine noise pollution, it is transboundary and cumulative in its impacts.[78] The extent and duration of the impact of the noise associated with oil and gas is difficult to measure, but it affects entire ecosystems and future generations of marine animals.[79]

Of particular concern are the seismic airgun surveys carried out to find oil and gas resources, which are among the loudest anthropogenic sounds.[82] These are much more intrusive than those used for other marine developments, such as windfarms.[80] They involve intense sound impulses[81] that can be detected 4000km away.[83]

Behaviour-altering noise extends over thousands of square kilometres around every seismic survey.[84]

For marine mammals, this can mean direct physical impacts, including hearing loss in bottlenose dolphins[85] which has serious implications for animals highly dependent on sound,[86] or in extreme cases, death.[87] It can cause them to reduce the echolocation they use for communication,[16] leave good feeding areas,[88] reduce hunting activity[89] and put precious energy into moving long distances to avoid the noise, diverting that energy from investing in producing young and therefore impacting future generations too.[90]

Large-scale analyses of UK seismic surveys have shown decreases in marine mammal sightings following seismic activity, with harbour porpoises and sperm whales showing the greatest sensitivity.[91,92] Minke whales have also demonstrated avoidance behaviour[92] and humpback whales changed their behaviour and avoid seismic activity, with a distance of up to 12km.[94] Seismic sound can change important migratory behaviours so that marine mammals find themselves in the wrong place at the wrong time and miss opportunities to feed or breed.

Bottlenose dolphins, for example, switched from their normal fish diet to feeding on seabed sponges[85] to avoid seismic noise. The smaller a marine mammal is, the more delicate the balance between energy derived from food and the energy needed to survive. For example, adding unnecessary detours into a harbour porpoise's daily life can have significant consequences, including increasing the risk of starvation.[95]

While older research has given an understanding of the importance of noise to whales and dolphins, the impact of anthropogenic noise on other marine life is only just being understood/researched.[75] For example, there is emerging research on the importance of hearing in turtles and the potential for impacts by seismic surveys and other marine noise.[96] Invertebrates can also be affected; for example, scallop larvae showed major fatal deformities following seismic impacts[97] and giant squid were found to have damage to tissue, organs, and their important sensing statoliths.[98] Negative effects linked to seismic sound have also been revealed from studies on crabs, cuttlefish,[99] lobsters,[100] mussels, octopus,[101] squid[98] and many other species and limited recovery from the effects was recorded a year after the seismic impact.[100]

The noise associated with seismic surveys also impacts fish and fisheries. Fishers are often concerned and report low catches following seismic surveys, which have also been confirmed in studies.[102-108] Research has shown, for instance, a stress response in North Sea Atlantic cod,[102,103] with impacts lasting for weeks. Catch rates of Atlantic cod also decreased during, and for at least 5 days after, a seismic survey.[104] Studies have shown negative impacts from seismic surveys on many other commercially important fish, including haddock,[105] blue whiting,[106] saithe[102] and sand eel species.[107,108] The impacts have included stress responses, behaviour change, permanent defects in fish larvae, reduction in the capacity of fish to breed successfully, and the life expectancy of individual fish.

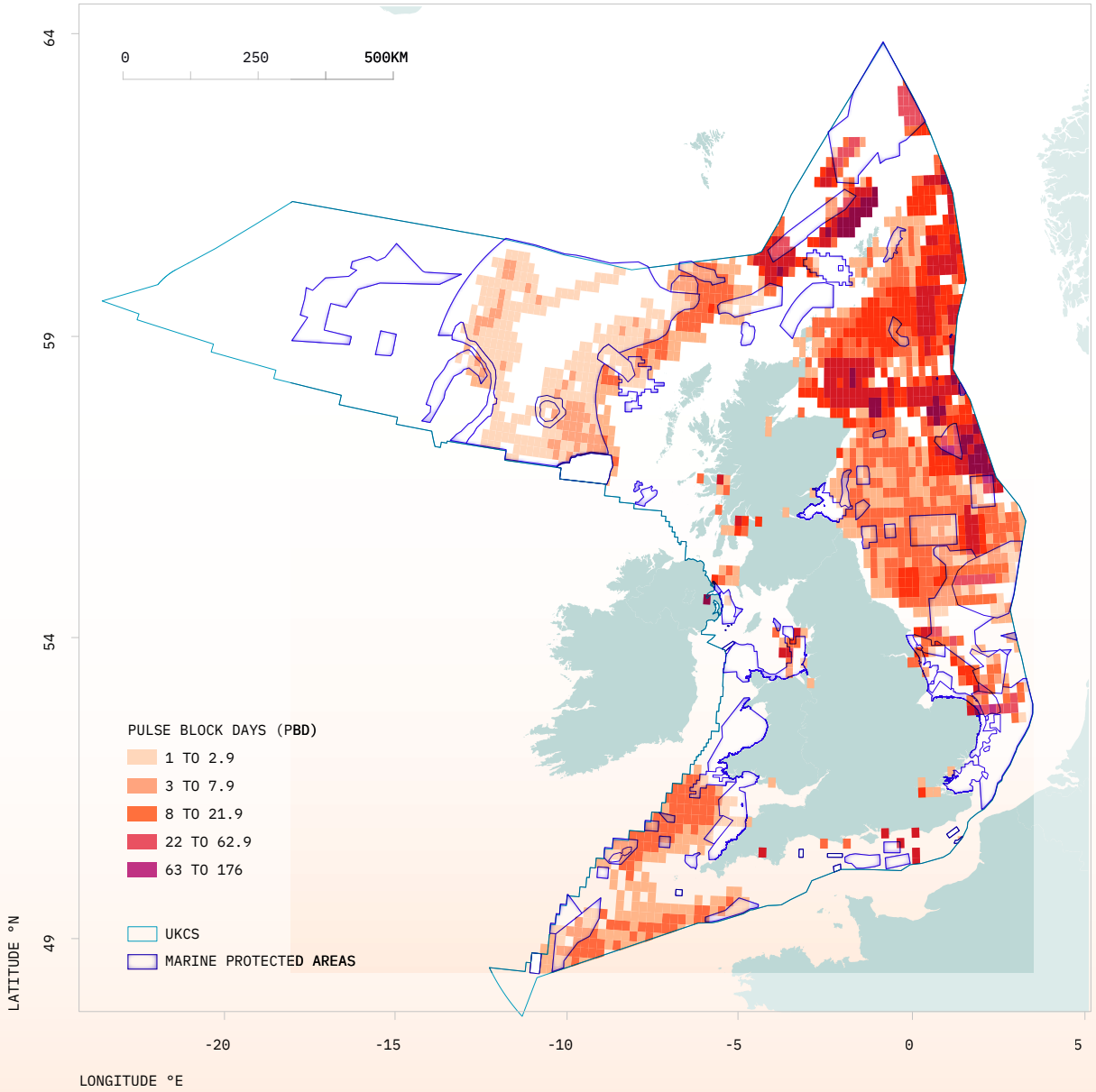


Figure 8. Map showing where showing the intensity of seismic activity from oil and gas exploration in UK seas

Seismic Noise is displayed as pulse block days (PBD): the number of days between 2015-2020 where a noisy activity occurred in an area. Analysis: Uplift and Zoological Society of London. Data: JNCC (2022)

New analysis by Uplift (Figure 8) highlights how the frequency and intensity of noise pollution associated with oil and gas seismic surveys are high throughout UK waters and even some of our Marine Protected Areas are subject to excessive noise for long periods.

Once offshore oil and gas reserves have been identified, further noise pollution is associated with the construction and drilling of exploration wells, as well as the installation and removal of the infrastructure at the end of its life.[28] The main impacts associated with construction are the noises related to drilling and piling for foundations and disturbance associated with a higher level of shipping and the movement of equipment. This type of noise causes changes in communication behaviour in dolphins and other marine mammal species. Construction noise can cause harbour porpoise to be displaced by around 20km.[109,110]

Underwater sound is generated from production platforms and operational activities, including drilling, vessel traffic and pipeline laying. Where the drilling rig or production platform relies on support and supply from other standby and supply vessels, these are often equipped with dynamically positioned thrusters and powerful engines and therefore contribute towards the overall noise level of drilling and production activities.[111] Oil and gas development and operation inevitably result in an overall increase in marine noise in the immediate area but over much wider areas too.

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2.4 Legacy

Aside from the massive long-term consequences of burning fossil fuel reserves, and the emissions, leaks and other pollutants released in the production process, there is a problem with the disposal of the extensive infrastructure left behind when production ceases. The disposal of offshore oil and gas infrastructure is another source of disturbance[112] and additional marine[113] and air pollution.[114]

The lifecycle of a typical oil or gas installation can be well more than 25 years,[23] after which these substantial and often still polluting installations must be removed from the marine environment to avoid further issues.

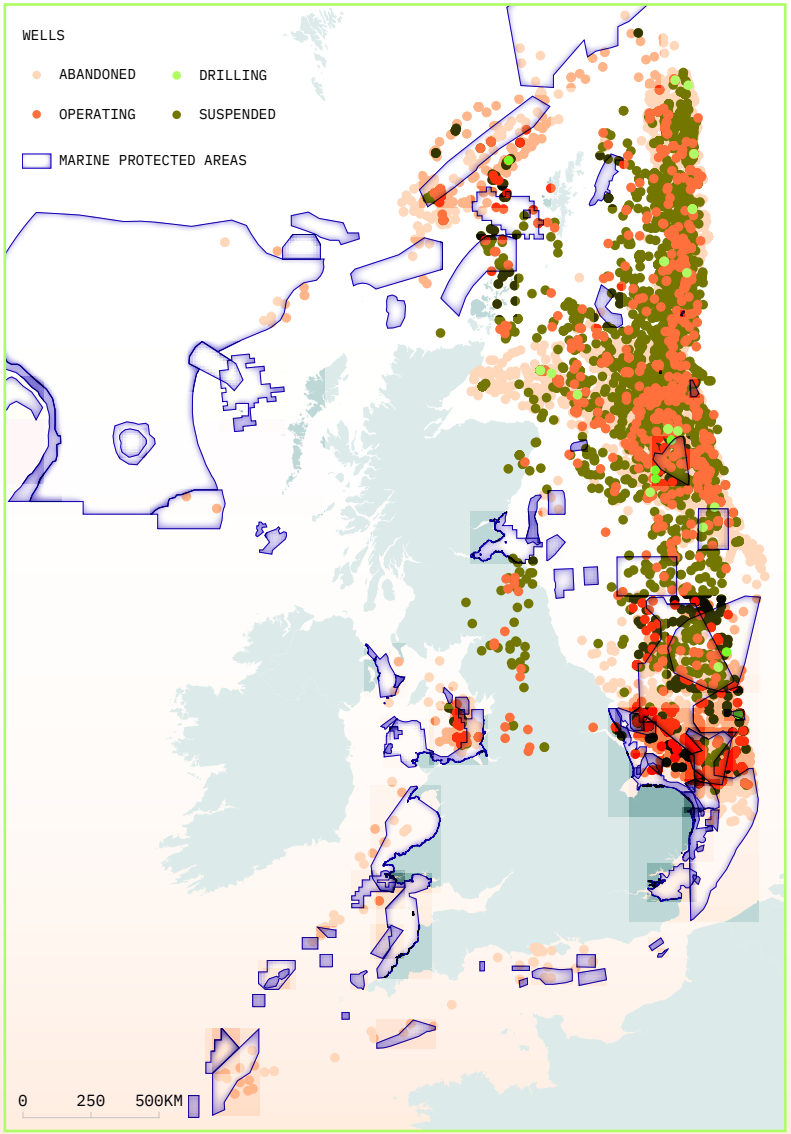
Long-buried toxic chemicals produced in the drilling and extraction process can be released as sediments are disturbed.[113] Naturally occurring radioactive materials from the petroleum reserves can build up within pipelines and other infrastructure, which can then also be released in problematic concentrations.[113] Further marine noise and disturbance is also created and there are ecological and logistical challenges to removing the large quantities of marine life that may have colonised the structure over decades.[115,116]

Before 1995, oil and gas infrastructure was disposed of – dumped – at sea.[117] This changed after the high-profile case of the Shell Brent Spar oil storage installation. Originally approved for disposal in the deep sea, it was eventually dismantled, and its parts recycled onshore after intense media coverage and political debate.[118] Since 1998, the dumping or abandoning of all or part of offshore installations has been prohibited.[119]

While there is an ongoing debate about the pros and cons of de-commissioning, in particular, over the loss of species that colonise offshore structures,[120,121] this infrastructure represents a major modification of the seabed and the loss of natural habitats and species. It also creates a long-term pollution issue associated with contaminated sediments, radioactive elements[113] and other toxic substances, which can accumulate up the food chain and potentially contaminate seafood.[113,122] Additional toxic chemicals are also used in decommissioning, including the cement used to plug abandoned wells (which often fail, leading to ongoing seepage of contaminants).[123]

If the UK government is serious about protecting and restoring the UK's marine environment, then the best option for our seas is to avoid the high costs[124] and additional issues associated with decommissioning by ceasing to approve new installations in the first place.

Figure 9. Map of boreholes from oil and gas drilling around the UK
Uplift analysis of North Sea Transition Authority Data



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Ocean Quahog Aggregations

Ocean quahogs are remarkable long-lived climate change sentinels and a priority species for conservation[278] and the designation of Marine Protected Areas[279–282] but they are under threat from existing[283] and new offshore oil and gas developments[284] leading to habitat loss and accumulating contamination.[285]

These thick-shelled bivalve molluscs are found in sandy and gravelly seabeds down to around 500 metres[286] and are best known for their remarkable longevity.[287] One Icelandic specimen was 507 years old, making them the longest-lived non-colonial animal. Centuries-old individuals have been regularly recorded from UK waters.[288] Their great age, and the fact that they lay down annual growth rings which provide information about the environment in which they were living, makes them extremely useful in the study of environmental history[289,290] and the science of climate change.[291,292] They are also used as indicators of environmental health, for example, both providing information about accumulating toxins like heavy metals through the concentrations in their shells and flesh[285] and their preference for less contaminated sediment.[293]

Their slow growth, time taken to reach maturity and longevity all contribute to making this species vulnerable to anthropogenic impacts[286] and it may take decades or even centuries for populations to recover.

They are an OSPAR threatened or declining species[294] and a 'feature of conservation interest' for Marine Conservation Zone designation in UK waters[279] and are critically endangered in the Baltic Sea.[250] The ocean quahog can occur in very low densities but also forms dense beds where there may be hundreds within a square metre and the North Sea has some of the highest densities recorded in the world.[295] The ocean quahog is a northern species at the southern-most extent of its range in the mid-North Sea and not extending all the way south and is therefore sensitive to temperature increases associated with climate change.[296]

The quahog has an important role in the productivity of sand and gravel ecosystems and is also an important food for cod[297] and other species. It is vulnerable to the chemical pollution associated with the offshore oil and gas industry and given its long lifespan, is particularly susceptible to persistent and accumulating pollutants such as PAHs and heavy metals.[285] Noise impacts have not been studied in the ocean quahog but evidence for impacts of seismic survey sound on other bivalves[97] highlights the potential for major development impacts.

Risks to ocean quahog aggregations have been highlighted in several MPAs with offshore oil and gas activity, including the Faroe-Shetland Sponge Belt MPA[298] and the North-east Faroe-Shetland Channel MPA where quahogs were surveyed within 50 metres of the hydrocarbon infrastructure.[263]

Figure 10. Offshore UK oil & gas extraction impacts of Ocean Quahogs



Quahogs live a remarkably long time: one was found to be 507 years old. They are important for the productivity of sand and gravel ecosystems and as a food source for commercially important atlantic cod.

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2.5 A Combination of Effects

The cumulative impacts of offshore oil and gas are particularly important to consider. This refers both to the combination of negative impacts of an individual development, which can impact the same species and habitats in multiple ways throughout the process, and how all the impacts of offshore oil and gas combined with other past, current, and future pressures on the marine environment, exacerbating the overall effects.[125]

A key challenge with cumulative impacts is that they are difficult to attribute, measure and monitor over time and therefore very difficult to mitigate.[126,127] They are also often underestimated.

It is important to note that impacts from pollution, habitat loss and noise from oil and gas developments are also exacerbated by the added pressures of climate change,[128] particularly increasing sea temperatures and changes in ocean chemistry.[129] For instance, as sea temperatures rise, oxygen levels can fall, which can make cold-water coral reefs more vulnerable to the effects of ocean acidification.[130] This can lead to the hard skeletons of the coral colonies weakening and becoming more susceptible to damage by development activities and less resilient to the impacts of pollution.[128] Ocean acidification is also increasing the toxicity of heavy metal pollutants and amplifying their impact on marine organisms.[131]

It is important to see the impacts of new oil and gas developments in the context both of existing projects and of all the other impacts on our marine environment. A more holistic approach to assessing and mitigating the cumulative impacts of offshore developments is urgently needed.[132]



Figure 11. Cold water corals

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Deep-Sea Sponge Communities

Deep-sea sponge communities are colourful, diverse and with highly varied shapes and textures they create deep-sea biodiversity hotspots[260] and important fish nursery grounds.[22] However, oil and gas impacts are leading to the loss of this habitat and serious degradation that will take decades if not centuries to recover.[22]

Sponge communities provide diverse ecosystem services[261] and they play an important role in the cycling of nutrients.[262] Up to 50 species of sponges are found in the sponge aggregations of the North-East Faroe-Shetland Channel MPA263 and these structurally diverse habitats provide homes for many other species including brittlestars, brachiopod (rare two-shelled animals unrelated to molluscs), squat lobsters and tube-building worms.[264]

Deep-sea sponge communities are recognised as Vulnerable Marine Ecosystems[265,266] and an OSPAR threatened/declining habitat.[222] These little-known habitats are only just beginning to be understood by scientists and newly discovered sponges and their associated bacteria have yielded novel pharmaceutical compounds.[267] But anthropogenic pressures, including those associated with offshore oil and gas, and exacerbated by climate impacts, are expected to deplete these species and impact the potency of the valuable compounds they produce.[268]

Sponge communities are particularly vulnerable to direct habitat loss as a result of drilling activities,[269] with studies showing complete loss of the habitat within 200 metres of drilling.[74] The sponges are smothered completely and die or are partially covered in sediment, hindering filtration and respiration,[270] or survive in an impaired state.[22] Those areas covered in drill cuttings may not show any recovery at all after 10 years.[74] If particularly damaging drill fluids are used (synthetic or oil based) then impacts to sponge habitats can be detected up to a kilometre away.[227] Oil-based drill fluids have largely been phased out in UK waters, as a result of OSPAR recommendations, but their impacts have been serious and widespread.[271] Sponge habitats are at risk from the proposed Cambo and Rosebank oil fields, with pipelines planned to run through prime sponge areas.[272,273]

Because sponges take in substances from the surrounding water both as dissolved matter and as particles, they accumulate the toxins produced and can act as a monitoring species, highlighting when high levels have been reached.[274] Some sponges are relatively resilient to oil pollution[275] while oil has impacted others' membranes. Impairment of reproduction and settlement have also been reported[275] and oil pollution can also impact the capacity of sponges to sequester carbon.[276] Important sponge species in these communities like *Geodia* are also susceptible to sea temperature increases associated with climate change.[277]

Figure 12. Offshore UK oil & gas activity impacts on deep-sea sponge communities



ENCROUSTING SPONGE AND BRITTLE STARS
ABERDEENSHIRE, SCOTLAND

Sponges create biodiversity hotspots. As filter feeders, they are particularly vulnerable to smothering from oil & gas drilling, which reduces their important capacity to lock-in carbon.

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2.6 Impact on Most Valuable and Protected Areas

Today, offshore oil and gas development is threatening some of the UK's flagship marine conservation initiatives and undermining decades of progress in marine protection, as well as the efforts of thousands of stakeholders and specialists.

Marine Protected Areas are places in the sea that are protected from damaging activities for the primary benefit of biodiversity and are increasingly seen as an essential part of UK and global marine conservation efforts.[133]

Evidence from the UK and around the world has shown how highly protected and effectively managed marine areas can boost biodiversity over a much larger area, support sustainable fisheries,[134] enhance community well-being,[135] offer improved resilience to climate change[136] and deliver other important services which benefit people and the wider environment. An effective MPA can also provide a haven for breeding and feeding fish and shellfish, which can boost catches in adjacent areas and ensure the long-term sustainability of fisheries.[137] A well-protected MPA also safeguards and enhances the whole suite of ecosystem services that the sea provides and on which we depend. They also provide reference sites which help scientists understand how a healthy ecosystem works.

Domestic and international climate action targets are driving larger areas and more effective protection for marine environments, including the goal to effectively protect 30% of seas by 2030, enshrined in the recently agreed Kunming-Montreal agreement.[138]

The UK has 374 MPAs[139] ranging from a few small highly protected areas where all fishing and development is banned to MPAs that presently have little additional protection from harmful activities, however, the management of MPAs is improving. In 2022 damaging bottom trawling fishing was banned in four key MPAs, including the Dogger Bank Special Area of Conservation,[144] offering the ecosystems more meaningful protection from harm, and a legal challenge by Oceana, a non-profit ocean conservation organisation, has forced the government to commit to managing all bottom towed fishing gear by 2024. Work is also underway to designate new Highly Protected Marine Areas in English[145] and Scottish waters,[146] offering much more effective protection. Many organisations, including Oceana, the Marine Conservation Society and Rewilding Britain,[147] are advocating for 30% of UK waters to be classed as Highly Protected Marine Areas by 2030.

This valuable and growing network of UK MPAs, however, is threatened by oil and gas development. Existing offshore oil and gas developments occur within or near many of our most important sites,[143] and new licences are now being issued that will encroach on protected areas.

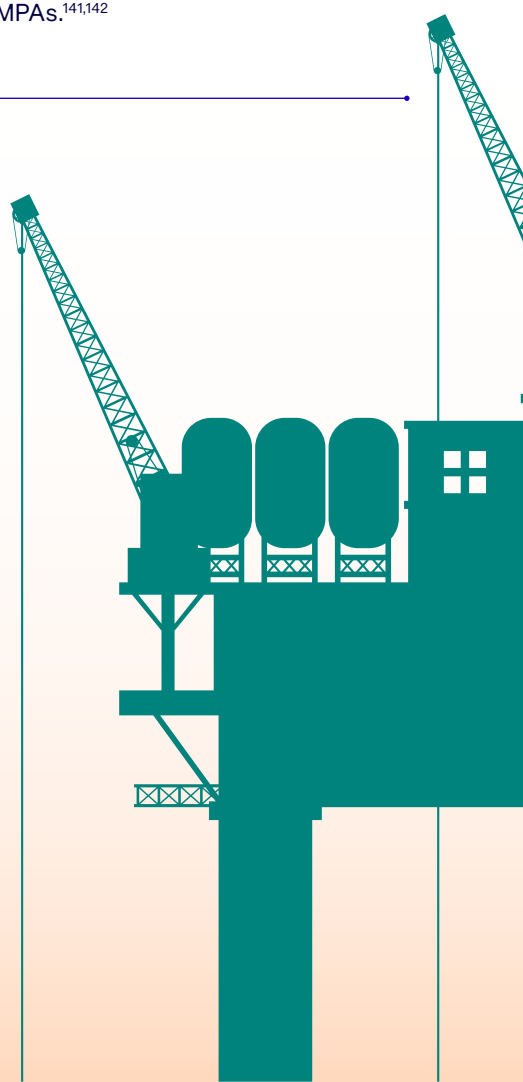
Analysis by Uplift shows that in the latest offshore oil and gas licensing round[140] 352, or well over a third of the nearly 900 locations being offered for development, fall within or overlap with designated MPAs. 166 of the sites are fully within a protected zone. This is despite international practice in Marine Protected Area management clearly stating that oil and gas extraction and other forms of offshore mining are incompatible with effective MPAs.[141,142]

352 of 900

In the latest offshore oil and gas licensing round well over a third of the nearly 900 locations being offered for development, fall within or overlap with protected areas of the uk's sea.

166

of the sites fall fully within a protected area.



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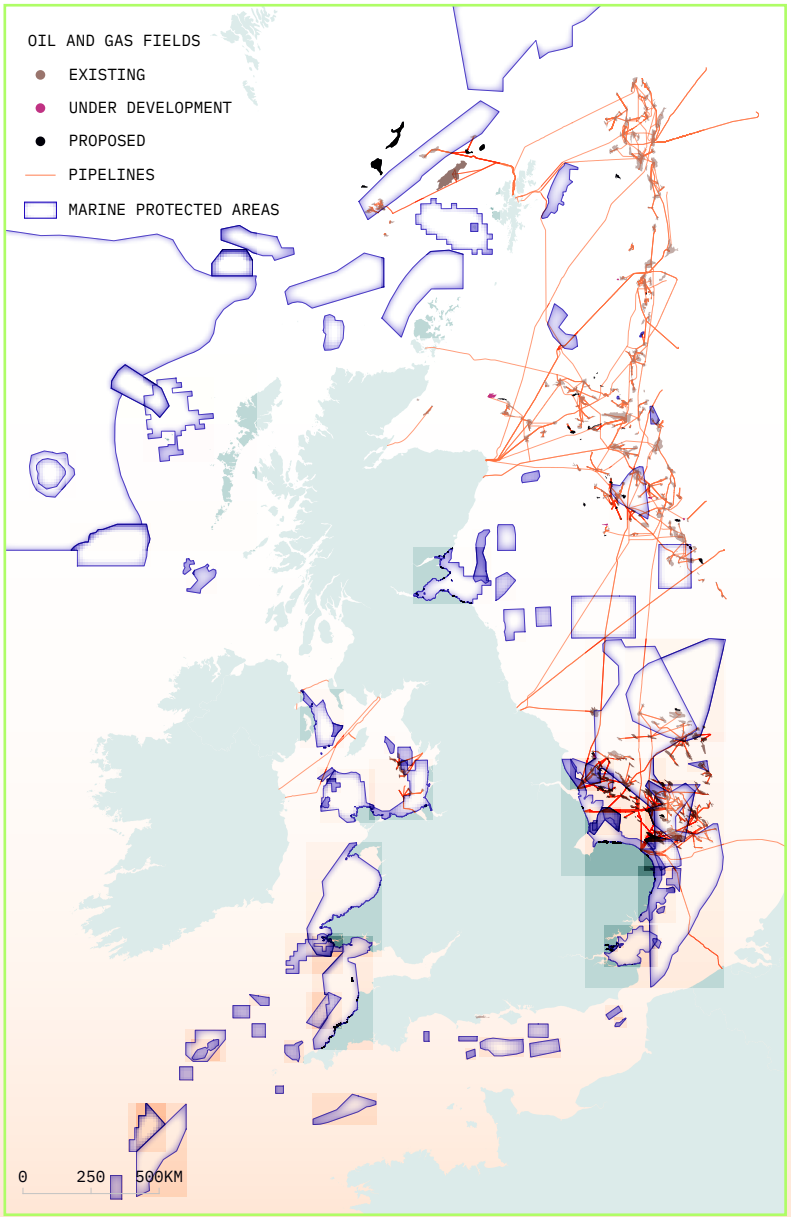
Given the noise, disturbance, pollution, and long-term disposal issues associated with offshore oil and gas, and it is an understatement to say continuing to licence developments within the UK's MPAs is counter-intuitive. Inappropriate industrial activity within MPAs is seen as a major impediment to their effective function,[148-149] and it limits the huge range of benefits to marine users and the wider environment. It is also largely unpopular with the public; in a recent survey, members of the public highlighted oil and gas extraction as one of the least compatible activities for a Marine Protected Area.[150]

The siting of MPAs and HPMAs is also critical to ensure that they fulfil their principal purpose of allowing the recovery of biodiversity. This means creating an ecologically coherent network of areas)[145,146] that are not adversely impacted by offshore oil and gas and locating protected areas away from oil and gas infrastructure. Inner Silver Pit South, for example, is a candidate to become a Highly Protected Marine Area[152] to protect blue mussel reefs, ross worm reefs and important foraging areas for seals, cetaceans and seabirds.[152] While the outlined marine protected area is free from any oil and gas proposals,[140] the site is surrounded by new licensing blocks. To position one of the UK's flagship marine protection sites amid the pollution, habitat loss and disturbance of new and existing offshore oil and gas developments, which could be in operation for decades to come, risks undermining the concept of HPMAs completely.

A related risk is the impact of oil and gas development on marine and coastal habitat restoration projects, which are becoming more common in MPAs. Expensive and high-profile projects around the UK coast are seeing biodiverse and potentially carbon-storing habitats like seagrass meadows[153] and oyster reefs[154] being restored after decades of decline.[155] Most projects are coastal and are therefore at most risk from oil and gas infrastructure where it comes to shore, as well as from catastrophic oil spills.

Considering these risks, in the case of offshore oil and gas, the best way to ensure the integrity of the UK's existing network of Marine Protected Areas would be to cease offshore oil and gas approval and licensing completely throughout UK seas and examine the ongoing impacts from existing oil and gas extraction within Marine Protected Areas very carefully.

Figure 13. Location of Marine Protected Areas, oil and gas fields and pipelines



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2.7 Risk to Blue Carbon: An Emerging Climate Solution

Healthy seas play a critical role in climate action[18]. The capacity for marine species and habitats to capture and store carbon and help curb climate change is threatened by the impacts of offshore oil and gas, and by the climate impacts they exacerbate.[156]

In 2022 the UK Climate Change Committee recommended that the UK strengthen marine protection and restoration, and support efforts to sustainably manage marine and coastal ecosystems, "*giving due consideration to their carbon value*".[157]

The impacts of offshore oil and gas must also now be carefully considered from a blue carbon perspective.

The concept of blue carbon has only gained mainstream attention in the past decade,[158] and the importance of carbon laid down in marine sediments and captured by marine species and habitats is now recognised as a leading nature-based solution for climate change.[159,160]

Currently, the best known and most comprehensively studied blue carbon habitats occurring in the UK are seagrasses and saltmarshes and are now under consideration to become the first marine habitats to be included in the UK national greenhouse gas inventory.[161] Marine algae, such as kelp forests can also play a role in carbon sequestration, although research on this is still developing.[162] In future, the protection and enhancement of these habitats will not just be important to conservation[163] but also relevant to international emissions reporting and compliance with domestic and international emissions reduction targets.[164–166]

Saltmarshes and seagrass beds are both coastal habitats, so are most at risk from large accidental oil spills which make landfall[167] or from habitat loss associated with bringing oil and gas to shore, such as pipelines, refineries and port infrastructure.[168] Seagrass meadows around the UK have been much depleted by human activities over the past century[155,169] and are also at risk from extreme heat events[170] which are made more likely and more severe by climate change.

In terms of total carbon accumulation, it is marine sediments that have the greatest capacity. Extensive work has been done in Scotland[171,172] and further south in the English North Sea[173] that has shown the importance of offshore sediments[157] in storing carbon. One of the threats to blue carbon habitats is fishing using trawls and dredges, but this damage is beginning to be addressed in some of the UK's MPAs, i.e., the new fishing restrictions recently introduced on the Dogger Bank.[144]

The impacts of offshore oil and gas must also now be carefully considered from a blue carbon perspective.[173] Blue carbon habitats can be lost directly when they occur in the development footprint of an oil and gas project or are impacted by a major oil incident. They are also at risk from smothering and long-term contamination by wastes and toxins released during operation.

Blue carbon is also stored in marine animals, and recent studies have highlighted how large fish[174] and marine mammals[175] which die naturally and sink to the bottom of deep-sea areas, can be a vital carbon store. This work is still developing, and it is unlikely that this blue carbon will be included in inventories in the near future,[176] but it highlights the complexity of nature-based climate solutions and the importance of healthy ecosystems.

As we have seen, the pollution and disturbance associated with offshore oil and gas can impact marine mammals, including some of our biggest animals such as sei and fin whales, which forage in, and migrate through, some areas of very high oil and gas activity. While these oil and gas impacts rarely kill whales and large fish outright, they do reduce their capacity to successfully reproduce. Increased climate change impacts[177,178] will also reduce future populations and the overall carbon that will ultimately be stored in the deep sea.

While blue carbon science is still developing and impacts on blue carbon reserves have yet to be officially accounted for, it is clear that offshore oil and gas is already impacting blue carbon in countless ways, making the case for it to be a key consideration in future licensing decisions.

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2.8 Climate Change Impact on Marine Ecosystems

Perhaps the most obvious and gravest impact that continued oil and gas production and use is having on the UK's seas[179] is its central role in driving climate change. The wide-ranging and long-term impacts on marine ecosystems are already visible, and research shows these are expected to accelerate.[128]

Increasing average sea temperatures are already impacting the distribution of UK species and habitats, with colder water species disappearing and warmer water species moving in.[180] Modelling using a medium emissions scenario predicted the loss of horse mussel reef habitat, a biodiversity hotspot,[50] from UK waters by 2080.[181] Additionally, the northern sea fan, the northern stone crab and the deeplet sea anemone have also been identified as vulnerable to rising temperatures.[182]

Climate change is driving changes in the seasonality, diversity, and abundance of plankton in the waters of the UK,[183] with a knock on effects on whole ecosystems. Phytoplankton (plants) or zooplankton (animals), are at the base of marine food webs, and climate-driven changes to their distribution can have knock-on effects throughout the food web. Substantial changes are already being documented; For example, zooplankton distribution is moving north by 200 to 250km per decade.[183] And the copepod *Calanus finmarchicus*, which is the favoured prey of many fish species, has been declining in the North Sea, while a similar species *Calanus helgolandicus* has been increasing.[183,184] Climate impacts on their plankton prey are also thought to be a factor in the changing distributions and population dynamics of cod.[185]

Warmer water species of cetacean like striped dolphin, short-beaked common dolphin, and Cuvier's beaked whale appear to be extending their ranges north and colder water species like the white-beaked dolphin may be experiencing a contraction in range.[186] There are also human health implications for increased sea temperatures; the disease-causing bacteria *Vibrio* showed a significant increase in the North Sea between 1958 and 2011.[187] Increasing seawater temperature could also lead to more harmful algal blooms (HARs) which can contaminate seafood,[183] with evidence of this from a major marine heatwave off Alaska in 2016.[188] There is also evidence for changes in vital nutrient cycling functions and primary production, which is the very basis of marine food chains.[128]

Oxygen dissolved in seawater is essential for marine life but climate change and other human impacts have led to its decline in the ocean since the 1960s[189] and it is expected to continue to decrease in UK waters as sea temperatures rise.[190] Oxygen deficiency is increasingly being recorded in the North Sea in late summer, in part because of climate change.[190] Oxygen depletion impacts all aspects of marine life and, in extreme cases results in death. It reduces the survival, growth, and the reproduction of marine animals and plants and can change their behaviour.[190]

Marine heat waves are intensifying and becoming more frequent[191] and can have serious and irreversible impacts on marine life.[191,192] They can impact blue carbon habitats, wiping out areas of seagrass where the high temperatures have been sustained for too long.[170] Marine heat waves are reaching deeper waters[188] and impacting a wide range of species and habitats, including sponges.[193]



STRIPED DOLPHIN

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GREAT SPIDER CRAB AND HYDROZONAS ON KELP

As atmospheric concentrations of carbon dioxide increase, so does the concentration of carbon dioxide dissolved in the ocean, leading to the ocean becoming increasingly acidic. The pH of the world's ocean has decreased by 0.1 since 1850 and is predicted to decrease by 0.3 by 2100.[128] This and other chemical changes are impacting species and ecosystems, with consequences for the large proportion of marine species that lay down hard skeletons.

There is already evidence of acidification impacts in UK waters. A study of planktonic marine snails in Scottish waters has shown shell damage that correlated with changes in ocean chemistry.[194] Habitats that depend on species with shells, such as oyster reefs, blue mussel beds, horse mussel reefs and maerl beds are thought to be particularly at risk from ocean acidification.[195] The deep-water coral *Lophelia pertusa*, present in UK waters, is expected to be increasingly vulnerable to ocean acidification and by 2060 it has been predicted that around 85% of UK cold-water corals could be exposed to corrosive waters.[130]

Climate change is also causing ice caps to melt and sea levels to rise which is particularly problematic for blue carbon-storing coastal habitats, like saltmarshes and seagrasses meadows which are suffering from coastal squeeze – habitat loss from encroaching sea levels on one side and expanding coastal development on the other.[156] UK weather patterns and sea conditions are also changing, including the frequency of storms.[196]

These changing conditions are expected to put increasing pressure on offshore infrastructure and could lead to more issues around both routine and catastrophic pollution from accidents like oil spills.

As an example, modelling of increases in wave height[197] showed a heightened risk to oil tankers. Another study highlighted how increased extremities in weather could make offshore structures more vulnerable to incidents impacting the environment.[198]

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2.9 Perpetuating Plastic Pollution

Offshore oil and gas are also making a major contribution to the ocean plastics crisis. The impacts of ubiquitous marine litter and specifically plastic pollution have been a big focus for ocean conservation in recent years[199,200] and plastics production is a major source of greenhouse gas emissions.[201] While the link is not always obvious, there are two main ways in which the offshore oil and gas industry contributes to plastic pollution, 1) microplastics used in offshore oil and gas industry, and 2) plastics are manufactured from oil and gas industry products.

Firstly, microplastics are used in the offshore oil and gas industry in substances such as demulsifiers and corrosion inhibitors which are discharged into the marine environment.[202] It has been estimated that in 2016 over 100 tons of microplastics were released into the North Sea by oil and gas operations;[203] and studies of sediments and marine creatures near installations have shown significantly higher levels of microplastics than elsewhere.[204]

Plastics are impacting some of our most precious habitats; research showed that 11% of marine creatures' samples from the East Mingulay Marine Protected Area in the Hebrides have ingested microplastics.[205] Plastic ingestion causes a wide range of negative impacts on species, from a reduction in energy reserves[206] to death.[207] There is still a lack of research and thus understanding of the impact of plastic pollution on ecosystems, however, concerns remain about the effect of plastics on blue carbon capacity[208] and other ecosystem services, including the contamination of seafood and the associated public health risks.[209]

Secondly, plastics are manufactured from oil and gas industry products and the industries are very closely linked.[210] It has been widely reported that oil and gas companies are increasingly promoting the use of their products in the plastics industry and investing in petrochemical infrastructure as demand reduces for transport and heating fuel.[211,212] Despite increasing national and international commitments to reduce plastic waste and to promote the reuse and recycling of plastics, commercial use of single-use plastics continues to grow in many sectors[213] and investment in the petrochemicals industry is growing.[214] To illustrate, Shell's revenue in 2019 included 3.9% from petrochemicals, which increased to 6.5% in 2020 [215]. By 2030 the petrochemical industry is forecast to account for more than a third of the projected growth in oil demand.[216]

This focus on increasing the production of plastic from fossil fuels rather than recycling existing materials or developing reusable options has grave implications for the sea and is fuelling the growing marine litter and plastic pollution crisis in UK waters and internationally.[201]



OIL & GAS EXTRACTION FUELS THE PLASTIC CRISIS:
CLOSE UP OF MICROPLASTICS RECOVERED FROM THE OCEAN

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2.10 Challenges Around Regulation and Management

The challenges facing the UK's seas outlined in this report underline the importance of having robust environmental safeguards and regulations that are properly implemented.

The UK has a good framework of environmental protection, which should ensure that new developments do not adversely impact marine species and habitats. However, analysis carried out for this report of the latest Offshore Energy Strategic Environmental Assessment,[217] (an assessment of whether the environmental impacts of the government's offshore energy plans outweigh the benefits), highlighted a wide range of short-comings around offshore oil and gas regulations. This indicates that environmental regulations are not necessarily offering the protection they should.

There is strong evidence that oil and gas companies are conducting poor quality environmental impact assessments (EIAs), when assessing offshore oil and gas developments.[219]

EIAs should flag up environmental risks and ensure there will be no adverse effects on MPAs or the wider environment,[218] however there is a lack of high quality EIAs with meaningful and effectively implemented mitigation measures of direct impacts.[220]

There is strong evidence that oil and gas companies are conducting poor quality environmental impact assessments (EIAs), when assessing offshore oil and gas developments.

A recent review recommended improvements in the detail provided in environmental statements on pollution, waste and greenhouse gas emissions, and the integration of a higher standard of effective mitigation methods. The need for a more consistent approach on assessing cumulative impacts was also highlighted, acknowledging the rising number of developments, and increasing threats to our marine life. International work has also highlighted the particular challenges around carrying out effective EIAs in deep sea environments,[221] which increases the risk of increased impacts from oil developments (a good example of this is the challenges of oil spill modelling for deep sites).[37]

The shortcomings of the EIA process is evident in an assessment of the environmental statement for the BP Alligin development, which lies within the Faroe-Shetland Sponge Belt MPA. It was expected to involve well-drilling, significant seabed infrastructure and the discharge at sea of over 1500 tonnes of water-based mud and drill cuttings. However, BP claimed that the development would not have any significant adverse impact on the MPA. This is an area known to have deep-sea sponge communities, an internationally recognised habitat of conservation concern,[222] ocean quahog aggregations, and many types of dolphins and whales recorded. The environmental statement concluded with: "*No significant adverse impacts are anticipated that would warrant specific mitigation measures or monitoring conditions*". Without a critical engagement, the UK regulator agreed and approved the project,[223] which began production in February 2020.[224]

The environmental work that underpins much of the approval and decision-making around offshore energy developments is informed by the Strategic Environmental Assessment (SEA) process.[225] It has emerged from analysis for this report and in feedback from environmental organisations that there is a general tendency for these assessments to dismiss or downplay some impacts of developments on the marine environment. Additionally, there are frequent delays in including new evidence or technical information in consultation responses not being adequately captured at all.

In the latest assessment, Offshore Energy Strategic Assessment 4 (OESEA4), [217] the impacts of seismic sound on marine mammal behaviour were classed as minor as they are "short-term impacts", despite the surveys often taking months to complete. Impacts of drilling on marine life are also downplayed despite a wealth of studies to the contrary.[60,71,74,226–228] The government report further dismissed contaminated drilling discharges because they are considered to disperse widely and not accumulate in significant quantities, despite evidence that PAHs found in drill cutting piles have had demonstrable negative effects on fish, including haemorrhages and lesions.[229,230]

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In the context of oil spill risk, OESEA4 states that mortality in marine mammals following oil exposure is unlikely, despite it having been observed in multiple studies on species such as otters,[30,231] common seals and orca[231] and bottlenose dolphins.[232] The important concept of the precautionary approach, which enables decision-makers to adopt precautionary measures when scientific evidence is uncertain, seems to rarely be implemented, despite being advised by OSPAR[233] and other good practice guidance.

Regulation around oil and gas activity is increasing and OSPAR highlighted progress in the use and discharge of problematic chemicals and in the decommissioning of infrastructure. But OSPAR also acknowledged that there is a real issue in understanding the reality of risks and impacts and actual consequences in the marine environment.[2] Harmful chemicals are still being discharged during decommissioning and better guidelines are needed to manage seismic surveys and other marine noise issues. Improved controls on the use and release of plastics in offshore oil and gas, and improved monitoring of cumulative impacts are also proposed; from 2023, OSPAR will be assessing the impacts of climate change on the sea area and will consider pollution prevention measures in the context of climate impacts.[2]

In the meantime, however, new oil and gas developments continue to be approved with all that means for the UK's seas.



BP DEEPWATER HORIZON OIL SPILL

2.11 International Good Practice

A few countries are taking considerable action, and leading the way in the phasing out of offshore oil and gas. Denmark, Ireland, France, Spain, Belize, Greenland, Costa Rica, Sweden, and Wales have all joined the Beyond Oil and Gas Alliance, launched at COP26 in Glasgow in 2021, and have all ceased new licensing and set clear targets for phasing out of oil and gas production.[234] Belize and Greenland cite marine environmental protection as the main driver for change.[235]

The approach these countries are taking accommodates the ongoing need for oil and gas while renewable alternatives become mainstream and comply with just transition commitments by helping businesses and individuals prepare and plan for the changes to come. Some regions and states have taken similar steps including New South Wales in Australia, which banned offshore oil and gas exploration in 2022.[236]

Many countries have specific policies relating to the protection of MPAs from offshore oil and gas impacts. In 2019, Canada banned oil and gas development in all its protected areas,[237] after it decided to adopt the highest standards set out in the International Union for Conservation of Nature (IUCN) Guidelines,[141,142] helping to redress the balance between prioritising oil and gas and protecting biodiversity.[238] This was reportedly partly in response to a public outcry to the announcement that the Laurentian Channel MPA – which protects among other things, porbeagle shark breeding grounds, leatherback turtles and sea pens[239] – would allow oil and gas extraction in all but 2% of its area.[151]

Most of the USA's National Marine Sanctuaries are similarly protected from oil and gas development.[240] Papahānaumokuākea Marine National Monument in Hawai'i is the largest contiguous fully protected conservation area under American jurisdiction and one of the largest MPAs in the world with an area of 1,508,870 km2, throughout which all exploring for, developing, or producing oil, gas, or minerals is prohibited.[241] In Australia, the Great Barrier Reef marine park (344,400 km2) has been completely protected from offshore oil and gas developments since its proclamation in 1975.[242]

While leading efforts to phase out oil and gas, these countries are also protecting their seas and the marine life they sustain.

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Conclusion: Our Future Seas

The UK's seas may have been heavily impacted and modified, but they are still **rich** and **beautiful** and contain oases of **wonder** and **diversity**.

Decisions about offshore oil and gas are not just about their significant and long-term contribution to greenhouse gas emissions, but also about the health of our beautiful and biodiverse seas that are essential for regulating climate. Continuing to license and approve new oil and gas production commits us to a whole suite of devastating impacts on the UK seas that will go on for decades and potentially have a much more prolonged negative legacy on our marine ecosystems.

The benefits to the UK from healthy seas extend far beyond sustaining fisheries, from new compounds for pharmaceuticals[243] to recreation[244] and wellbeing[245] to protection of our coasts from erosion[14]. A wide range of initiatives are currently investing in healthier UK seas, establishing Marine Protected Areas and strengthening their protection, restoration and rewilding areas. Furthermore, helping nature to rebuild the oyster reefs and seagrass meadows that we have lost, improve the management of fisheries, innovate to reduce the footprint of trawling and dredging, and develop sustainable aquaculture. All these actions will be undermined by new offshore oil and gas projects and not just for the next few years, but for decades.

The accepted evidence and advice from the UN and scientists around the world is that real protection of the ocean is essential for human life and for regulating our climate. Halting the licensing and approval of new offshore oil and gas would not just be an opportunity for the UK to build on its offshore wind success and become a leader in just transition to phase out oil and gas extraction,[23] it would also be an enormous endorsement of the UK government's commitment to marine conservation and the protection of biodiversity.

Importantly, they still have the capacity for recovery to the fish-filled waters sustained by rich reefs that we had historically.

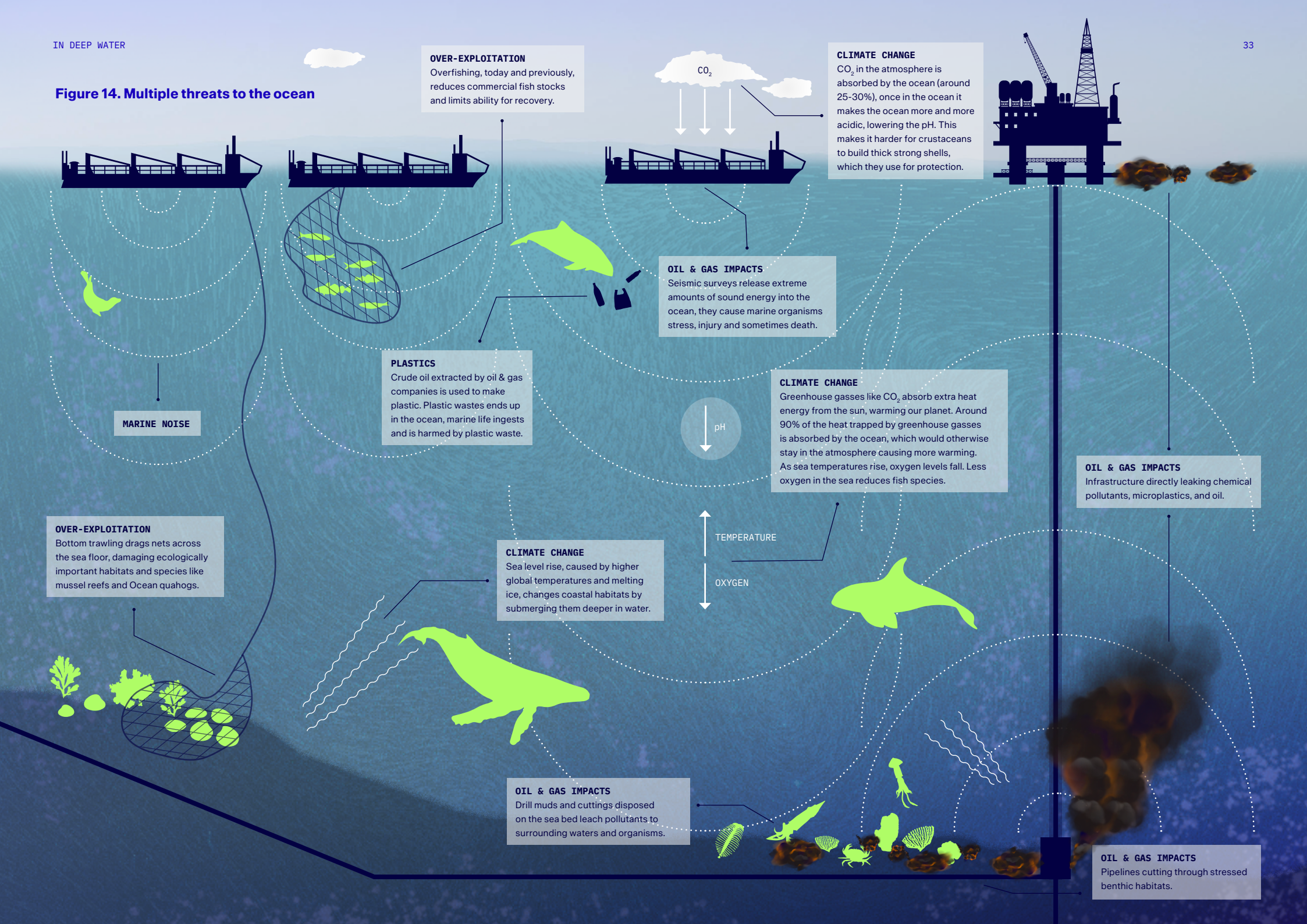
The ocean is already key in mitigating the worst of climate change.[18] Over 90% of the heat trapped by rising carbon dioxide is absorbed by the ocean and 25-30% of carbon dioxide that would otherwise stay in the atmosphere and cause more warming. Without that capacity, we would be in a much worse situation today.

This is the capacity of a degraded ocean that we have not been looking after properly. There is great potential for much more carbon storage in a healthy, well-protected ocean, with numerous highly protected marine reserves, with minimal bottom trawling and dredging and with all the other impacts on marine ecosystems significantly reduced. This unrealised potential for the ocean to be a much more effective climate action tool is becoming increasingly acknowledged, fuelling calls for more effective ocean protection.

The conflict between expanding oil and gas extraction and protecting marine biodiversity is a global experience, with hydrocarbon extraction impacting marine ecosystems around the world. However, routine co-location with Marine Protected Areas is rare.[246] For a country claiming to be a world leader in climate action and marine conservation, this lack of consistency is shocking and it is time the public was more aware of this issue.

Stopping new oil and gas infrastructure and extraction will reduce the problems we are storing up for future generations. These are long-term commitment to emissions and infrastructure, the noise and pollution, the expensive and complex decommissioning challenges and along with it a long list of impacts on our marine environment.

Figure 14. Multiple threats to the ocean



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Considering the wide range of marine ecosystem impacts associated with offshore oil and gas, in addition to the devasting climate impact of continuing to extract fossil fuels, the over-riding policy recommendation is to **halt licensing and approval of new offshore oil and gas extraction in UK waters**.

This advice is underpinned by guidance from the International Energy Agency[4] and a wide range of UK and global analysis. Halting the licensing of new offshore oil and gas projects in the UK will benefit international climate action and the UK's international reputation.

The current unfolding situation with hundreds of new licences being awarded and dozens of new oil and gas installations up for approval or coming online over the next few years is completely incompatible with a healthy future for our seas. All our marine areas need to be well managed to sustain and support us in an uncertain future, but it is particularly important that the UK government ramps up the protection of our most diverse and productive sites, many of which fall within our MPA network.

The seas around the UK are wonderful and diverse and full of life and they are a vital part of climate solutions.[13, 247] But instead of delivering on domestic and international commitments for ocean conservation, with each new oil and gas licensing, they are becoming more industrialised and places that are too noisy, too polluted, too built-up, and too disturbed for our marine life to thrive.

Allowing new offshore oil and gas projects will not cut our energy bills or increase our energy security. It will build more infrastructure and create more emissions which are at odds with domestic and global climate commitments. Committing to halt this rapidly outdated industry will allow us to recover our marine ecosystems, including better-managed MPAs, and more sustainable fisheries, prioritising renewable offshore energy and restore the rich and beautiful seas to which we all aspire.



OIL SPILL CLEAN-UP

Case Studies: Marine Protected Area

Marine Protected Areas (MPAs) are supposed to be some of our most special and highly protected sea areas, where marine life can thrive, be safe from human impacts and can deliver government commitments for clean, healthy, diverse, and productive seas supporting people and nature.[299]

Whilst many people are now aware of the widespread impacts of destructive fishing methods like trawling and dredging in MPAs,[300] very few people appreciate the extent of oil and gas activity in these places, or the direct and indirect effects fossil fuel extraction is having on our most important ocean places.



DEAD MAN'S FINGERS WITH POLYCHAETE AND A COMMON SUNSTAR
ST ABB'S HEAD, SCOTLAND

Figure 15. Oil and gas impacts on features and functioning of Marine Protected Area

FUNCTION OF A GOOD MPA

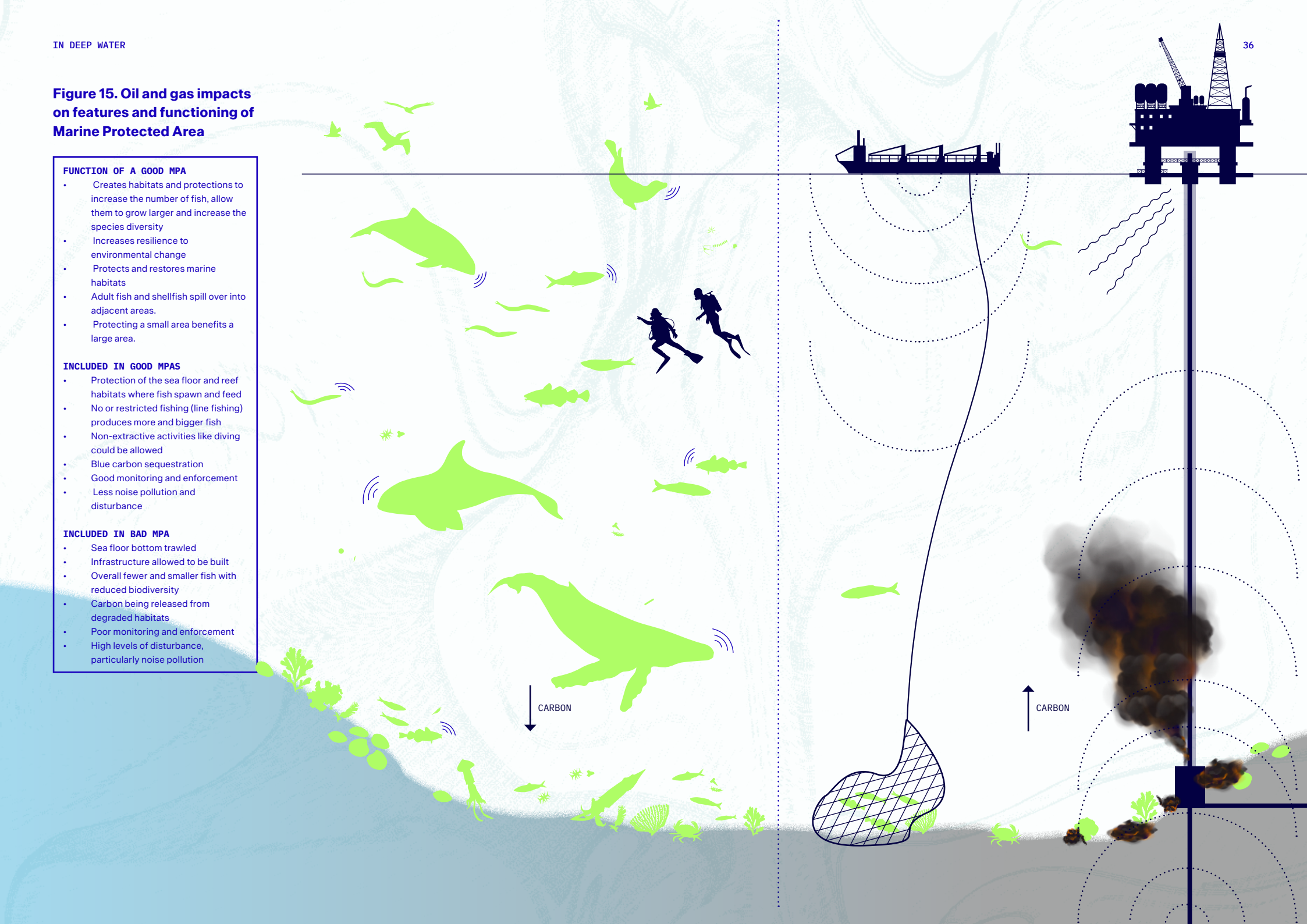
- Creates habitats and protections to increase the number of fish, allow them to grow larger and increase the species diversity
- Increases resilience to environmental change
- Protects and restores marine habitats
- Adult fish and shellfish spill over into adjacent areas.
- Protecting a small area benefits a large area.

INCLUDED IN GOOD MPAS

- Protection of the sea floor and reef habitats where fish spawn and feed
- No or restricted fishing (line fishing) produces more and bigger fish
- Non-extractive activities like diving could be allowed
- Blue carbon sequestration
- Good monitoring and enforcement
- Less noise pollution and disturbance

INCLUDED IN BAD MPA

- Sea floor bottom trawled
- Infrastructure allowed to be built
- Overall fewer and smaller fish with reduced biodiversity
- Carbon being released from degraded habitats
- Poor monitoring and enforcement
- High levels of disturbance, particularly noise pollution



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5.1 Dogger Bank Special Area of Conservation

Dogger Bank Special Area of Conservation (SAC) is a rich, productive, and unique sandbank feature[301] in the North Sea that has sustained sand eel and commercially important fish populations for centuries.[302] It overlaps substantially with the Southern North Sea SAC[303] which is designated to protect harbour porpoise populations.[303] It is regarded as a particularly important part of the UK MPA network because it is the largest single expanse of a sandbank in UK waters, including more than 70% of the UK's sandbank habitat, and its glacial formation makes its sandbank feature particularly interesting.[304]

In 2022 trawling and dredging were banned in the MPA,[144] improving the protection offered to the sandbank habitat conservation feature. With this protection, recovery of currently scarce species including the thornback ray[305] could be possible. However, current and any future oil and gas activity undermine existing and future protection and drastically reduce the benefits which could be delivered by the mobile fishing ban.

Within the boundary of the Dogger Bank Special Area of Conservation, our analysis has shown there are **176 wells, 13 platforms and a network of 633 km of associated pipelines**.

The marine life associated with the sandbank habitat includes worms, amphipods, bivalves, crabs, flatfish, and dense aggregations of brittlestars.[306] There are areas of soft coral, branching bryozoans (sea chervil) and reef-building tubeworms (serpulids).[307] Sand eels support a diverse ecosystem, prey species for grey seals and common seals,[308] harbour porpoises[303,309] and many species of seabird. Ocean quahogs are also found here.[306] Minke whales, long-finned pilot whales, bottlenose dolphins, common dolphins, white-beaked dolphins, and Atlantic white-sided dolphins use the area too.[310]

The Dogger Bank SAC is already heavily impacted by the offshore fossil fuel industry. Within the boundary of the SAC, our analysis has shown there are 176 wells, 13 platforms and a network of 633 km of associated pipelines. The estimated physical footprint of the platform and well infrastructure is 0.188km2. The estimated area impacted by the associated drill cuttings for these wells and platforms is 71 km2.[311]

In terms of noise impacts on cetaceans, the focus here is on the potential impacts on harbour porpoises, as a designated feature of the Southern North Sea SAC.[303] Harbour porpoises are particularly sensitive to disturbance and vulnerable as their high metabolic rate, small size and low-fat reserves mean behavioural responses are potentially costly.[75,77] Where disturbance increases energy demands or decreases foraging efficiency there is the potential for significant effects on survival at the level of the individual and population.[95] Behavioural and physiological responses to both continuous and impulsive anthropogenic noises have been observed in porpoises.[312, 77] When echolocation detectors were deployed on Dogger Bank at an offshore gas platform before, during and after construction, coupled with detectors at control sites to monitor porpoise activity,[255] they reported displacement with significantly less porpoise activity during the year-long drilling and construction phase, with activity returning to baseline levels five months post construction.

5.2 East of Gannet and Montrose NCMPA

East of Gannet and Montrose Fields Nature Conservation MPA is important for ocean quahog and unusual deep-sea mud habitats but both features are rated as an unfavourable condition.[313] This is unsurprising as the site is extensively used for offshore oil and gas.[314] Rather than work to recover the site, additional new areas are currently on offer for oil and gas development as part of the latest licensing round[315] which will have further adverse effects.

The MPA was proposed for the protection of ocean quahog aggregations and offshore deep-sea muds.[314] Offshore subtidal sand and gravel habitats at depths between 80 and 100m, which are suitable for colonisation by ocean quahog are also included as a designated feature.[316] The offshore deep-sea muds present are one of the few examples of Atlantic-influenced offshore deep-sea mud habitats on the continental shelf in the region[317] and this is the only MPA in the northern North Sea designated to protect offshore deep-sea muds[318] which are being increasingly acknowledged for their blue carbon value.[173]

The muddy sediment, sea pens and presence of *N. norvegicus* burrows are all indicative of the OSPAR habitat 'sea pen and burrowing megafauna communities'[319] and the UK Biodiversity Action Plan priority habitat

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'Mud Habitats in Deep Water'.[320] Three species of sea pens have been reported from the site,[318] and the site also includes important habitat for the Norway lobster,[313] a burrowing crustacean with an important role in oxygenating the upper sediment layers.[321]

There is extensive hydrocarbon activity in the northern and western parts of the MPA. There are a total of 225 wells, 4 platforms and 827km of pipeline. The estimated physical footprint of the platform and well infrastructure is 0.179km². The estimated area impacted by the associated drill cuttings for these wells and platforms is 55 km². This infrastructure is thought likely to have impacted ocean quahog populations in the MPA.[313] Recovery of populations from disturbance is likely to be extremely slow, on the order of centuries.[313] It is thought that UK waters act as a sink for the species, with larval recruits originating from Icelandic waters and long periods between successful recruitment events. It is, therefore, important that the abundance and age structure is conserved in the long term to maintain the population within the site.[313]

While cetaceans are not a designated feature of the MPA, there is scope for noise impacts on cetacean species which are still protected by law throughout UK waters. Based on their distribution and observations, harbour porpoises, white-beaked dolphins, Atlantic white-sided dolphins, bottlenose dolphins and minke whales are the most likely species to be impacted by noise in the EGMF MPA.[322–324] A high level of seismic survey activity has been reported throughout this site, with implications for marine mammals and other species.

5.3 Faroe-Shetland Sponge Belt Nature Conservation Marine Protected Area

This large MPA is a biodiversity hotspot of international importance, home to diverse sponge aggregations, and frequented by long-finned pilot whales, Atlantic white-sided dolphins and many other residents and migrant marine mammals.[298] Hydrocarbon exploration and production activities have been taking place in the Faroe-Shetland Channel since the early 1990s[22] and a large proportion of this MPA is currently being offered in the latest licensing round315, threatening more habitat loss, disturbance, and pollution.

The Faroe-Shetland Sponge Belt Nature Conservation MPA is home to diverse boreal ostur sponge communities unlike those found anywhere else and is categorised as a Vulnerable Marine Ecosystem,



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of international value and interest.[266] They create rich and productive habitats for many other species including endangered sharks, rays and chimaerae.[261,264] They are important in ocean nutrient cycling[325] and are likely to be important for fisheries.[263]

In addition to the sponge communities, the main ecological features for designation are ocean quahog aggregations and offshore subtidal sands and gravels. The conservation status of all these features is classed as unfavourable. The area is interesting from an oceanographic point of view, where warm Atlantic water overlies cold water from the Norwegian sea,[326] creating an extreme and varying thermal gradient which influences the biodiversity of marine life in the area.[327] Other species of conservation interest include anemones, cup corals, sea pens, and soft corals and ocean curiosities including sea spiders with 40cm leg spans and enormous basket stars, relatives of normal starfish but with ultra-branching arms with over 5000 arm tips.[328]

The Faroe-Shetland Channel is well known for its abundance of large whales and dolphins.[329,330,331] Fin whales are thought to be seasonal migrants and summer visitors, and there are also occasional sightings of blue whales, sei whales and humpback whales. Long-finned pilot whales, Atlantic white-sided dolphins, white-beaked dolphins, and harbour porpoises are all common in the MPA. Oil and gas activity is already underway near these features of conservation interest.[263]

Within the boundary of Faroe-Shetland Sponge Belt MPA, there are 285 wells, 543 km of pipeline and currently no platforms. The estimated physical footprint of the well infrastructure is 0.29km². The estimated area impacted by the associated drill cuttings for these wells is 57 km². A study of the Laggan field which is within the MPA showed major impacts on seabed ecology after drilling and only partial recovery after 10 years.[74] The construction and operation of oil infrastructure have a visible impact on the distribution of marine species that have been studied using seafloor imaging.[332]



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