

The Impact of EMF on Aquatic Life, Flora and Fauna, Wildlife and Biodiversity in the Gate Burton Energy Park.

The limitation of 1500 words on Written Representations has changed the format of a single submission to individual subject specific submission on EMF.

1. Written Representation (WR) on EMF Electromagnetic Fields (EMF)

EMFs are the very essence of everything living on Earth, but we know so much and so little about it.

The World Health Organisation states that EMF, in all frequencies represent one of the most common and fastest growing environmental influences, about which anxiety and speculation are spreading. All populations are now exposed to varying degrees of EMF, and the levels will continue to increase as technology advances. Electromagnetic radiation has been around since the birth of the universe; light is its most familiar form. Electric and magnetic fields are part of the spectrum of electromagnetic radiation which extends from static electric and magnetic fields, through radiofrequency and infrared radiation, to X-rays.

Contrary to popular opinion, we know a great deal about how EMFs affect non-human species because we have been using animal and plant models in research going back at least to the 1930's (1). Such research may have been conducted with humans in mind but can also be extrapolated to non-human species protection.

The focus of this Written Representation is to recognise the unique physiology of EMF and to accept the adverse and significant effect on aquatic life, flora and fauna, wildlife and biodiversity that prevails.

Ambient levels of nonionizing electromagnetic fields (EMF) have risen sharply in the last five decades to become a ubiquitous, continuous, biologically active environmental pollutant.

Almost 4,971 mi (8,000 km) of high voltage direct current (HVDC) cables were present on the seabed worldwide, 70% of which were in European waters, and this is only expected to grow dramatically as new sources of renewable energy are built to replace fossil fuels globally.

These are all man-made artifacts.

The developer has identified a myriad of cable runs in the project resulting in connections carrying up to 400Kv to transport electricity from the solar panels to the National Grid at Cottam Power Station using transformers, inverters etc.

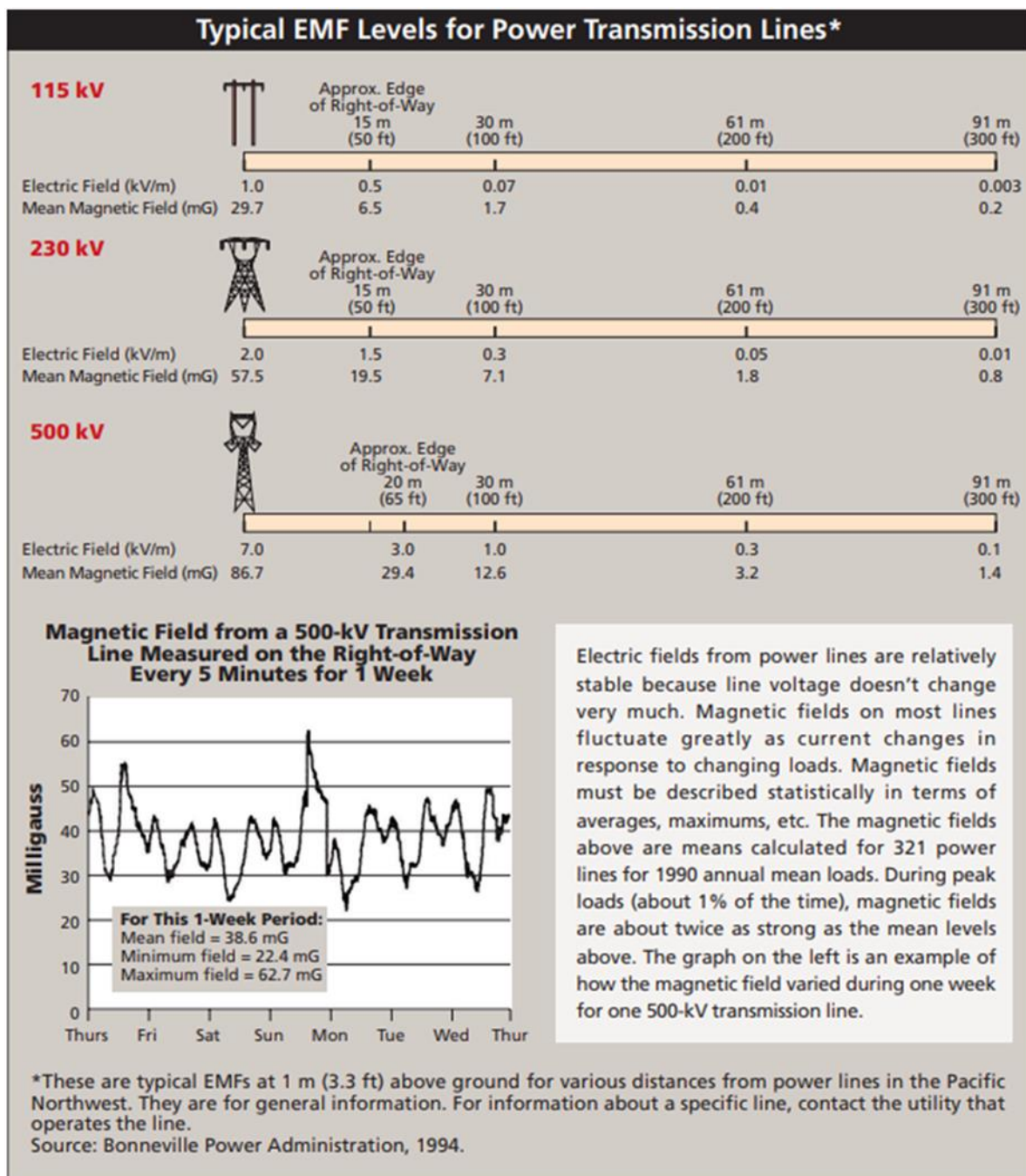
There are many watercourse cable crossings including the Rivers Trent and Till and their tributaries. The river crossings will be subject to temporary horizontal directional drilling (HDD) and **will make provision for additional and possible future cabling from Cottam, West Burton, Tillbridge and other solar projects significantly impacting the consideration of EMF.**

Conventional overhead power lines of this size, linked to the National Grid must have a clearance height of at least 7 metres.

The cable carrying power lines at ground level in the project of 400Kv will have a greater effect on EMF than if they were 7 metres above ground level.

The magnetic fields will be significantly stronger, and the effect of EMF will be distanced further away by at least 7 metres.

For example, a magnetic field measuring 57.5 milligauss immediately beside a 230 kilovolt transmission line measures just 7.1 milligauss at 100 feet, and 1.8 milligauss at a distance of 200 feet, according to the World Health Organization in 2010.



Summary EMF

1. The Cottam Solar Project states: "that in the absence of information relating to the potential for impacts, the Proposed Development on fish species, **the Inspectorate does not agree to scope this matter out**".
2. The ES should include a description of the sensitivity of relevant watercourses and any seasonal constraints on such crossings, assessing likely significant effects on riverine species where they are likely to occur".
3. The developer has only made a minor consideration of EMFs in human life but nothing on the significant impact on aquatic life, flora and fauna with wildlife, and biodiversity, where all the later are intrinsically linked to each other.
4. Existing exposure standards are for humans only; aquatic life, flora and fauna and its wildlife are unprotected including within the safety margins of existing guidelines, which are inappropriate for trans-species sensitivities and different non-human physiology.
5. The developer has identified a myriad of cable runs in the project resulting in connections carrying up to 400Kv to transport electricity from the solar panels to the National Grid at Cottam Power Station using transformers, inverters etc., all of which transmit EMF's.
6. The cables carrying power lines **at ground level** in the project of 400Kv will have a greater effect on Electromagnetic Fields than if they were 7 metres above ground level.
7. The magnetic fields created on the development site will be significantly stronger, and the effect of EMF will be distanced further away by at least 7 metres.
8. A magnetic field measuring 57.5 milligauss immediately beside a 230 kilovolt transmission line measures just 7.1 milligauss at 100 feet, and 1.8 milligauss at 200 feet, according to the World Health Organization in 2010.
9. **This WR has shown that almost 100 years of research identifies that all species in aquatic life, flora and fauna and its wildlife and associated biodiversity are affected by EMF. Is the Developer, Examiner and the Secretary of State satisfied that there is no risk to any species from the effect of EMF and its features as a result of the Project?**

2. WR the effect of EMF on Aquatic Life

Aquatic Life

The oceans, seas and rivers with their inhabitants are extremely important for the survival of us humans. The oceans regulate the climate of the planet and produce most of the oxygen. Millions of people depend on a healthy marine ecosystem for their livelihoods. **What happens when, through our ill-considered and selfish intervention, the oceans can no longer maintain their vital functions for the entire planet?**

No radiofrequency (RFR) emission guidelines today take non-human species into consideration, despite constant measured rising background levels in urban, suburban, and rural areas [see Supplement 1 in reference (23)] that are capable of affecting wildlife and plants [see Supplement 3 and 4 in reference (24)]. This includes guideline allowances for RFR (100 kHz-300 GHz) created by the International Commission on Non-ionizing Radiation Protection (ICNIRP), as well as a member organization of the American National Standards Institute (ANSI) called the International Electronics and Electrical Engineers (IEEE) that has written exposure guidelines for frequencies between 0 Hz and 300 GHz.

Many European countries, as well as Canada and Australia, have traditionally adopted ICNIRP guidelines, sometimes with slight variations.

The rivers and oceans with their inhabitants are extremely important for the survival of us humans. The oceans regulate the climate of the planet and produce most of the oxygen. Millions of people depend on a healthy marine ecosystem for their livelihoods. What happens when, through our ill-considered and selfish intervention, the rivers and seas can no longer maintain their vital functions for the entire planet?

The mighty River Trent, whose 271km long journey begins near Stoke-on-Trent and ends in the sea at the Humber Estuary is special and is one of the UKs most important rivers.

It has been used as a navigation since Roman Times and in 867 AD, the Danish Vikings came up the Trent to Snottingham in their longships.

Its catchment helps feed the nation, nourishes the communities that live on its banks and supports a huge diversity of natural habitats that need both our protection and help with recovery and reconnection. We are facing an ecological emergency with 15% of all UK wildlife under threat from extinction and our rivers are a critical factor in this.

There have been extensive EMF wildlife reviews published between 2003 and 2021 (10–22). Recently, Levitt et al. (23–25) extrapolated to broad ecosystem level effects for the first time, including extensive tables that match rising ambient levels to effects seen at vanishingly low intensities now common in the environment as chronic exposures.

Many animals have evolved other special receptor organs. This unique ability allows electric fish to distinguish subtle differences in electrical properties within its immediate vicinity, including the electric fields of other fish, via electroreceptors capable of detecting a field of 5 nV/cm. While such evolutionary perceptual adaptations are extremely efficient and sensitive, they also render such species exceptionally vulnerable to unnatural anthropogenic fields.

The primary concern for aquatic species is from AC-ELF exposures from underwater cabling and other technologies, not RF which is of more concern for ground-based and aerial species (24).

Radiofrequency radiation may also affect natural “natal homing behaviour”—the astounding ability of some species like sea turtles (90); eels (91); and salmon (42–44), among others—to return to their original birth location to reproduce. The underlying mechanism, though imperfectly understood, involves such species being “imprinted” with the exact location of their birth, likely through geomagnetic configurations, then “remembering” it at reproduction time even when thousands of kilometres away.

The Water Framework Directive and its work identifies amongst other species the European eel/elvers that is on the IUCN Red List, and on the OSPAR list of threatened and/or declining species and habitats and protected under the European Eel Regulation (European Commission) No 100/2007 and the Eels (England and Wales) Regulations 2009.

The Canal and Rivers Trust, along with Notts Biological & Geological Records Centre, identifies, in the rare and protected fish including Allis shad, Brook lamprey, Bullhead, Common/European Sturgeon, Crucian carp, Eel, River lamprey, Sea lamprey, Smelt, Spined loach, Twaite shad and the White-clawed crayfish. Brown Trout and the Atlantic Salmon, all in the River Trent.

Salmon had completely disappeared from the Trent River system by about the mid-1930s. where previously the River Trent and its tributaries historically sustained a native population of many thousands of salmon, with net fisheries reporting catches from the River Trent of around 3000 fish.

For the past five years, the water quality in the River Trent has been such that once again salmon could survive in the river on their passage to the cleaner waters of the tributary breeding streams.

This has been achieved by the introduction of about 150,000 young salmon to the River Dove each year since 1998. This program has resulted in the first observation for 70 years of returning breeding adult fish in the River Trent.

Current Legislation affecting salmon includes the following: Atlantic Salmon are protected under the Salmon and Freshwater Fisheries Act 1975, supplemented by the Salmon Act 1986, and the species is listed under the EC Habitats Directive Annex 11a.

Summary Aquatic Life

1. It is noted that the Cottam Solar Project states “that in the absence of information relating to the potential for impacts, the Proposed Development on fish species, **the Inspectorate does not agree to scope this matter out.** The ES should include a description of the sensitivity of relevant watercourses and any seasonal constraints on such crossings, assessing likely significant effects on riverine species where they are likely to occur”.
2. The rivers and oceans with their inhabitants are extremely important for the survival of us humans. The oceans regulate the climate of the planet and produce most of the oxygen. Millions of people depend on a healthy marine ecosystem for their livelihoods.
3. What happens when, through our ill-considered and selfish intervention, the rivers and seas can no longer maintain their vital functions for the entire planet?
4. We are facing an ecological emergency with 15% of all UK wildlife under threat from extinction and our rivers are a critical factor in this.
5. The primary concern for aquatic species is from AC-ELF exposures from underwater cabling shown in WR1 and other technologies, not RF which is of more concern for ground-based and aerial species (24).
6. It is important that fish and other significant aquatic life species both rare and protected, or those on the endangered list are recognised and their existence continues and thrives.
7. Is the Developer, ExA and the Secretary of State satisfied that there is no risk to any aquatic species from the effect of EMF and its features as a result of the Project?

3. WR the effect of EMF on Flora and Fauna and Wildlife

Flora and Fauna and Wildlife

Many species of flora and fauna, because of unique physiologies and habitats, are sensitive to exogenous EMF in ways that surpass human reactivity. This can lead to complex endogenous reactions that are highly variable, largely unseen, and a possible contributing factor in species extinctions, sometimes localized.

Numerous studies across all frequencies and taxa indicate that current low-level anthropogenic EMF can have myriad adverse and synergistic effects, including on orientation and migration, food finding, reproduction, mating, nest and den building, territorial maintenance, and defence, and on vitality, longevity and survivorship itself.

Many species rely on the Earth's natural EMFs for daily movement, seasonal migration, reproduction, food-finding, and territorial location, as well as diurnal and nocturnal activities. Most harmful radiation coming from outer space is blocked by the Earth's magnetosphere. But now, we have infused the Earth's surface with a blanket of artificial energy exposures with no clear understanding of what the consequences may be.

There is enough evidence to indicate we may be damaging species at ecosystem and biosphere levels across all taxa from rising background levels of anthropogenic non-ionizing electromagnetic fields (EMF) from 0 Hz to 300 GHz leaving wildlife unprotected.

The literature is voluminous on EMF effects to nonhuman species, going back at least to the 1930s using modern methods of inquiry. We have, after all, been using animal, plant, and microbial models in experiments for decades.

We may in fact know less about effects to humans than to other species. In this WR, focus is on exposures common in today's environment.

There is no question that the huge diversity of pollinator species across the planet is suffering and that losses could be catastrophic with an estimated 90% of wild plants and 30% of world crops in jeopardy. There is a likelihood that rising EMF background levels play a significant role.

Bees have been known for decades to have an astute sense of the Earth's DC magnetic fields, and rely on that perception for survival. For centuries beekeepers had noticed curious movements in beehives but Austrian ethologist Karl von Frisch finally interpreted that activity in the 1940s, winning the Nobel Prize in 1973 for what came to be known as the honey bee "waggle dance." Through complex circles and waggle patterns, bees communicate the location of food sources to other members of the hive, using the orientation of the sun and the Earth's magnetic fields as a gravity vector, "dancing" out a map for hive members to follow like nature's own imbedded GPS. Bees also detect the sun's direction through polarized light and on overcast days use the Earth's magnetic fields, likely through the presence of magnetite in their abdominal area, and employ complex associative learning and memory.

RFR effects seen in bees include significant inhibitory effects on sensory olfactory, excitability, short term memory impairment, induced worker piping—the sound that initiates swarming behaviour in colonies, reduction of worker bees and reduced egg laying by queens exposed to radiation and colony collapse disorder. Most of these studies were conducted in non-thermal ranges and non-linear effects were often seen, with the lower exposures causing the greater effects. see Balmori (16).

We may already be overwhelming some species' natural biological sensors that evolved over eons. Such heightened sensitivities function far beyond human perception and create unique vulnerabilities that can easily be disturbed by novel man-made fields.

Despite classic assumptions that non-ionizing radiation cannot directly damage DNA, genotoxic effects have been seen in land-based, aerial, aquatic, and plant species at very low intensity RFR exposures far below ICNIRP/IEEE/FCC guidelines. There are at least 48 papers showing DNA damage after exposure to RFR at < 0.4 W/kg [see Supplement 1 in reference (24)].

Insects are of special concern as populations are being decimated globally (24).

Depending on insect type and exposure duration, Michaelson and Lin (1) back in 1987 noted sequential insect reactions to RFR (at high intensities): insects first tried to escape, followed by motor disturbance and coordination problems, including stiffening, immobility, rigidity, and eventually death.

Ants also react adversely to RFR (109–111). Cammaerts et al. (111) found that memory and association between food sites and visual/olfactory cues in ants (*Myrmica sabuleti*) was significantly inhibited, with memory eventually wiped out altogether, from exposures to GSM-900 MHz signal at 0.0795 $\mu\text{W}/\text{cm}^2$.

Affected insect groups included niche specialist species, as well as common and generalist species, many of which are critically important for pollination, as well as seed, fruit, nut and honey production, and natural pest control, among others of immeasurable economic and ecological value.

Since all food webs are uniquely tied together, there are negative cascading effects across all ecosystems.

Many species can sense natural DC magnetic fields in diverse ways including migratory bird species (38, 39); numerous insect species including honeybees (40, 41); fish (42–47); mammals (48); bats (49); molluscs (50), and bacteria (51, 52). Some bird species may actually 'see' the Earth's magnetic fields via complex magnetoception capabilities (53) located in their eye and beak areas.

The magneto mechanical model involves the naturally occurring iron-based crystal called magnetite (78–80) that has been found in most species studied, often in very different physiological areas. Magnetite-based orientation/interactions are patterned according to the geomagnetic field. Magnetite is highly reactive to external electromagnetic fields—a million times more strongly than any other known magnetic material. The abdominal areas of honeybees, for instance, contain magnetite with complex nerve endings feeding into it and can detect static magnetic field fluctuations as weak as 26nT against background earth-strength magnetic fields that are much higher (79). They can also sense weak alternating fields at frequencies of 10 and 60 Hz (79). Bees are also affected by RFR as discussed below.

Many species of flora and fauna, because of unique physiologies and habitats, are sensitive to exogenous EMF in ways that surpass human reactivity. This can lead to complex endogenous reactions that are highly variable, largely unseen, and a possible contributing factor in species extinctions, sometimes localized.

Numerous studies across all frequencies and taxa indicate that current low-level anthropogenic EMF can have myriad adverse and synergistic effects, including on orientation and migration, food finding, reproduction, mating, nest and den building, territorial maintenance and defence, and on vitality, longevity and survivorship itself.

Summary Flora and Fauna and Wildlife

1. We may in fact know less about effects to humans than to other species. In this WR, focus is on exposures common in today's environment.
2. There is enough evidence to indicate we may be damaging species at ecosystem and biosphere levels across all taxa from rising background levels of anthropogenic non-ionizing electromagnetic fields (EMF) from 0 Hz to 300 GHz leaving wildlife unprotected.
3. Despite classic assumptions that non-ionizing radiation cannot directly damage DNA, genotoxic effects have been seen in land-based, aerial, aquatic, and plant species at very low intensity RFR exposures far below ICNIRP/IEEE/FCC guidelines.
4. There are at least 48 papers showing DNA damage after exposure to RFR at < 0.4 W/kg [see Supplement 1 in reference (24)]. Insects are of special concern as populations are being decimated globally (24).
5. For centuries beekeepers had noticed curious movements in beehives, but Austrian ethologist Karl von Frisch finally interpreted that activity in the 1940s, winning the Nobel Prize in 1973 for what came to be known as the honey bee "waggle dance."
6. Electro-ecological interplay between flowers and pollinators has also been known since the 1960s and is critical to pollen transfer from flowers to bees.
7. Since all food webs are uniquely tied together, there are negative cascading effects across all ecosystems.
8. There is no question that the huge diversity of pollinator species across the planet is suffering and that losses could be catastrophic with an estimated 90% of wild plants and 30% of world crops in jeopardy.
9. Taken as a whole, this indicates enough information to raise concerns about ambient exposures to radiation at ecosystem levels. Wildlife loss is often unseen and undocumented until tipping points are reached. It is time to recognize ambient EMF as a novel form of pollution and develop rules at regulatory agencies that designate air as 'habitat' so EMF can be regulated like other pollutants.
10. There is no question that the huge diversity of pollinator species across the planet is suffering and that losses could be catastrophic with an estimated 90% of wild plants and 30% of world crops in jeopardy. There is a likelihood that rising EMF background levels play a significant role.
11. We may already be overwhelming some species' natural biological sensors that evolved over eons. Such heightened sensitivities function far beyond human perception and create unique vulnerabilities that can easily be disturbed by novel man-made fields.
12. Is the Developer, ExA and the Secretary of State satisfied that there is no risk to any species of flora and fauna and wildlife from the effect of EMF and its features as a result of the Project?

4. WR the effect of EMF on Biodiversity

Biodiversity

Since all food webs are uniquely tied together, there are effects of EMF across all ecosystems, flora and fauna, food and aquatic life and human life and the significant cascading effect on biodiversity.

Most of what has been submitted specifically in WR1, WR2, WR3 equally applies to this WR4.

There has been an unprecedented rate of biodiversity decline in recent decades according to the International Union for Conservation of Nature which maintains a “Red List of Threatened Species” that is considered the world’s most comprehensive source on the global conservation status of animal, fungi and plant species — all critical indicators of planetary health.

The International Union for Conservation of Nature (IUCN) 2018 list showed that 26,000 species are threatened with extinction, which reflected more than 27% of all species assessed. This was greatly increased from their 2004 report that found at least 15 species had already gone extinct between 1984 and 2004, and another 12 survived only in captivity.

Other species have vastly more complex electromagnetic sensing tools than humans, as well as unique physiologies that evolved to sense weak fields. Many species are highly sensitive to the Earth’s natural electromagnetic fields, as well as geographic and seasonal variations. In fact, it appears that most living things — including many species of mammals, birds, fish, and bacteria — are tuned to the Earth’s electromagnetic background in ways once considered as “superpowers” but are now known to be physiological, even as mechanisms are still imperfectly understood.

This ability is due to numerous species reacting to changes in the Earth’s magnetic field and electrostatic charges in the air detected through a naturally occurring mineral called magnetite found in many species. In fact, honeybees are able to detect static magnetic field fluctuations as weak as 26nT against background earth-strength magnetic fields that are much higher and to sense weak alternating fields at frequencies of 10 and 60 Hz. Magnetite reacts a million times more strongly to external electromagnetic fields than any other known magnetic material.

Species that hug the ground, like snakes, salamanders, and frogs, have unique exposures to ground currents, especially on rainy nights when water, as a conductive medium, can increase exposures.

Summary Biodiversity

1. There has been an unprecedented rate of biodiversity decline in recent decades according to the International Union for Conservation of Nature.
2. Their 2018 list showed that 26,000 species are threatened with extinction, which reflected more than 27% of all species assessed. This was greatly increased from their 2004 report that found at least 15 species had already gone extinct between 1984 and 2004, and another 12 survived only in captivity.
3. Many years of research studying the effects from both natural and man-made EMF over a wide range of frequencies, intensities, wave forms, and signalling characteristics have been observed in all species of animals and plants.
4. The database is now voluminous with studies showing biological effects at both high and low-intensity man-made exposures, many with implications for wildlife health and viability.
5. Sensitive magnetoreception allows living organisms, including plants, to detect small variations in environmental EMF and react immediately as well as over the long term, but it can also make some organisms exquisitely vulnerable to man-made fields.
6. EMF may be contributing more than we currently realize to species' diminishment and extinction. Exposures continue to escalate without understanding EMF as a potential causative and/or co-factorial agent. It is time to recognize ambient EMF as a potential novel stressor to other species.
7. There are two prevalent misconceptions today about how low-level non-ionizing EMF couples with and affects non-human species:
 - i). There is no need for environmental concern since exposures as currently regulated are too low to cause effects; and
 - ii). Existing exposure standards for humans are sufficient to cover non-human species too.

Neither supposition is accurate.

8. **We have a long over-due obligation to consider potential consequences to other species – an obligation we have thus far not considered before more species go extinct.**
9. Is the Developer, ExA and the Secretary of State satisfied that there is no risk to any species of flora and fauna and wildlife from the effect of EMF and its features as a result of the Project?

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