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February 9, 2024

To: Government of Canada
Submitted by email to: nature2030@ec.gc.ca

RE: The Canada 2030 National Biodiversity Strategy Milestone Document, Target 7: Pollution and Biodiversity Should Address Wireless and EMFs.

We thank the Government of Canada for considering our comments on the Milestone Document which will frame Canada's 2030 National Biodiversity Strategy. The Environmental Health Trust (EHT) is a not-for-profit scientific think tank that promotes a healthier environment through research, education and policy.[1]

EHT shares in the Milestone Document mission of "working together to halt and reverse biodiversity loss and put nature on a path to recovery by taking urgent action to bring about transformative change for the benefit of all living things, including people."

We urge the Government of Canada to include the reduction of non ionizing electromagnetic fields (EMFs) in Target 7: Pollution and Biodiversity as EMFs are a rapidly increasing environmental pollution that needs critical attention and mitigation. Inaction on this critical environmental issue will have far reaching and irreversible consequences.

Wireless Radiation and Non-ionizing Electromagnetic Fields are a Rapidly Increasing Environmental Pollution

Research shows that environmental levels of radiofrequency radiation have rapidly increased over the last few decades and levels are highest in close proximity to base station antennas.[2]

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[1] www.EHTrust.org

[2] Bandara, P., & Carpenter, D. O. (2018). Planetary electromagnetic pollution: It is time to assess its impact. The Lancet Planetary Health, 2(12), e512–e514; Brown, R. (2022). Assessment of radiofrequency radiation intensity on 35 Main Streets throughout Pennsylvania, USA during the fall of 2021. American Journal of Multidisciplinary Research & Review. 1(4). 8-20; Mazloum, T., Aerts, S., Joseph, W., & Wiart, J. (2019). RF-EMF exposure induced by mobile phones operating in LTE small cells in two different urban cities. Annals of Telecommunications, 74(1), 35–42.; Koppel, T., Ahonen, M., Carlberg, M., Hedendahl, L. K., & Hardell, L. (2019). Radiofrequency radiation from nearby mobile phone base stations-a case comparison of one low and one high exposure apartment. Oncology Letters, 18(5), 5383–5391; Koppel, T., & Hardell, L. (2022). Measurements of radiofrequency electromagnetic fields, including 5G, in the city of Columbia, SC, USA. World Academy of Sciences Journal, 4(3), 1–12.; El-Hajj, A. M., & Naous, T. (2020). Radiation Analysis in a Gradual 5G Network Deployment Strategy. 2020 IEEE 3rd 5G World Forum (5GWF), 448–453.; Boussad Y, Chen XL, Legout A, Chaintreau A, Dabbous W. (2022) Longitudinal study of exposure to radio

The current research base clearly indicates that wireless radio frequency (RF) radiation as well as other non ionizing EMFs can lead to harmful impacts to humans as well as flora and fauna. Just because the exposure is non-ionizing, does not mean it cannot have biological impacts.

Scientific research has documented a broad range of impacts to humans and animals at levels far below government limits including cancer,[3] increased oxidative stress,[4] genetic damage,[5] structural and functional

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frequencies at population scale. Environ Int.Apr;162:107144 ; Sagar, S. et al. (2018). Comparison of radiofrequency electromagnetic field exposure levels in different everyday microenvironments in an international context. *Environment International*, Volume 114, 297-306.

[3] Miller, A. B., Morgan, L. L., Udasin, I., & Davis, D. L. (2018). Cancer epidemiology update, following the 2011 IARC evaluation of radiofrequency electromagnetic fields (Monograph 102). Environmental Research, 167, 673–683. https://doi.org/10.1016/j.envres.2018.06.043; Falcioni, L., Bua, L., Tibaldi, E., Lauriola, M., De Angelis, L., Gnudi, F., Mandrioli, D., Manservigi, M., Manservisi, F., Manzoli, I., Menghetti, I., Montella, R., Panzacchi, S., Sgargi, D., Strollo, V., Vornoli, A., & Belpoggi, F. (2018). Report of final results regarding brain and heart tumors in Sprague-Dawley rats exposed from prenatal life until natural death to mobile phone radiofrequency field representative of a 1.8 GHz GSM base station environmental emission. *Environmental Research*, *165*, 496–503. .; Directorate-General for Parliamentary Research Services (European Parliament), & Belpoggi, F. (2021). Health impact of 5G: Current state of knowledge of 5G related carcinogenic and reproductive/developmental hazards as they emerge from epidemiological studies and in vivo experimental studies. (PDF) Publications Office of the European Union; James C. Lin. (2022) Carcinogenesis from chronic exposure to radio-frequency radiation. Front. Public Health, Sec. Radiation and Health. 31 October; Lerchl, A., Klose, M., Grote, K., Wilhelm, A. F. X., Spathmann, O., Fiedler, T., Streckert, J., Hansen, V., & Clemens, M. (2015). Tumor promotion by exposure to radiofrequency electromagnetic fields below exposure limits for humans. Biochemical and Biophysical Research Communications, 459(4), 585–590.

[4] Yakymenko, I., Sidorik, E., Kyrylenko, S., & Chekhun, V. (2011). Long-term exposure to microwave radiation provokes cancer growth: Evidence from radars and mobile communication systems. *Experimental Oncology*, *33*(2), 62–70.https://pubmed.ncbi.nlm.nih.gov/21716201/; Georgiou, C. D., & Margaritis, L. H. (2021). Oxidative Stress and NADPH Oxidase: Connecting Electromagnetic Fields, Cation Channels and Biological Effects. *International Journal of Molecular Sciences*, *22*(18), 10041; Lai, H., & Levitt, B. B. (2023). Cellular and molecular effects of non-ionizing electromagnetic fields. *Reviews on Environmental Health*; Schuermann, D., & Mevissen, M. (2021). Manmade Electromagnetic Fields and Oxidative Stress—Biological Effects and Consequences for Health. *International Journal of Molecular Sciences*, *22*(7), 3772.

[5] Smith-Roe, S. L., Wyde, M. E., Stout, M. D., Winters, J. W., Hobbs, C. A., Shepard, K. G., Green, A. S., Kissling, G. E., Shockley, K. R., Tice, R. R., Bucher, J. R., & Witt, K. L. (2020). Evaluation of the genotoxicity of cell phone radiofrequency radiation in male and female rats and mice following subchronic exposure. Environmental and Molecular Mutagenesis, 61(2), 276–290; Panagopoulos D. J. (2019). Chromosome damage in human cells induced by UMTS mobile telephony radiation. General physiology and biophysics, 38(5), 445–454; Blank, M., & Goodman, R. (2011). DNA is a fractal antenna in electromagnetic fields. International Journal of Radiation Biology, 87(4), 409–415; Cantu, J. C., Butterworth, J. W., Peralta, X. G., Payne, J. A., & Echchgadda, I. (2023). Analysis of global DNA methylation changes in human keratinocytes immediately following exposure to a 900 MHz radiofrequency field. Bioelectromagnetics, 44(3–4), 77–89; Lai, H. (2021). Genetic effects of non-ionizing electromagnetic fields. Electromagnetic Biology and Medicine, 40(2), 264–273; Megha, K., Deshmukh, P. S., Banerjee, B. D., Tripathi, A. K., Ahmed, R., & Abegaonkar, M. P. (2015). Low intensity microwave radiation induced oxidative stress, inflammatory response and DNA damage in rat brain. Neurotoxicology, 51, 158–165; Panagopoulos, D. J., Karabarbounis, A., Yakymenko, I., & Chrousos, G. P. (2021). Human-made electromagnetic fields: Ion forced-oscillation and voltage-gated ion channel dysfunction, oxidative stress and DNA damage (Review). International Journal of

changes of the reproductive system,[6] memory deficit,[7] behavioral problems[8], and neurological impacts.[9]

Further, studies have found impacts to tree canopy, plant growth, pollinator health and the orientation, migration and breeding of wildlife.[10] Effects have been documented in all species studied.[11] Thankfully, most RF EMF exposures can be mitigated with existing superior non-wireless technologies. If wired technology is prioritized, the need for "everything wireless" is reduced and environmental levels can be drastically reduced. Ecologically sensitive areas need to be protected with additional mitigation.

We note that wireless and non-ionizing electromagnetic radiation is defined as a type of "pollution" by the wireless companies themselves. According to pg. 9 of the Telus Device Care Complete Program, "Pollution" is defined as "The discharge, dispersal, seepage, migration or escape of pollutants. Pollutants means any solid, liquid, gaseous, or thermal irritant or contaminant including smoke, vapor, soot, fumes, acid, alkalis, chemicals, **artificially produced electric fields, magnetic field, electromagnetic field, sound waves, microwaves, and all artificially produced ionizing or nonionizing radiation** and/or waste." Similar

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Oncology, 59(5), 1–16.

[6] Kim S, Han D, Ryu J, Kim K, Kim YH. Effects of mobile phone usage on sperm quality - No time-dependent relationship on usage: A systematic review and updated meta-analysis. Environ Res. 2021 Nov;202:111784. doi: 10.1016/j.envres.2021.111784. Epub 2021 Jul 30. PMID: 34333014; Kaur P, Rai U, Singh R. Genotoxic Risks to Male Reproductive Health from Radiofrequency Radiation. Cells. 2023; 12(4):594; Chu KY, Khodamoradi K, Blachman-Braun R, et al. (2022) Effect of Radiofrequency Electromagnetic Radiation Emitted by Modern Cellphones on Sperm Motility and Viability: An In Vitro Study Eur Urol Focus.;S2405-4569(22)00247-4. doi:10.1016/j.euf.2022.11.004; Dasdag, S., Muzaffer T., Mehmet Z.A., & Korkut Y., (2015) Effect of long-term exposure of 2.4 GHz radiofrequency radiation emitted from Wi-Fi equipment on testes functions, Electromagnetic Biology and Medicine, 34:1, 37-42; Houston, B. J., Nixon, B., King, B. V., De Iuliis, G. N., & Aitken, R. J. (2016). The effects of radiofrequency electromagnetic radiation on sperm function. Reproduction (Cambridge, England), 152(6), R263–R276; Jangid, P., Rai, U., Sharma, R. S., & Singh, R. (2022). The role of non-ionizing electromagnetic radiation on female fertility: A review. International Journal of Environmental Health Research, 0(0), 1–16; Koohestanidehaghi Y, Khalili MA, Fesahat F, Seify M, Mangoli E, Kalantar SM, Annarita Nottola S, Macchiarelli G, Grazia Palmerini M. (2023) Detrimental effects of radiofrequency electromagnetic waves emitted by mobile phones on morphokinetics, oxidative stress, and apoptosis in mouse preimplantation embryos. Environ Pollut. Nov 1;336:122411.

[7] Swiss Tropical and Public Health Institute. "Mobile phone radiation may affect memory performance in adolescents, study finds." ScienceDaily. ScienceDaily, 19 July 2018. <www.sciencedaily.com/releases/2018/07/180719121803.htm>.

[8] Divan HA, Kheifets L, Obel C, Olsen J. Cell phone use and behavioral problems in young children. J Epidemiol Community Health. 2012 Jun;66(6):524-9. doi: 10.1136/jech.2010.115402. Epub 2010 Dec 7. PMID: 21138897.

[9] Hiie Hinrikus, Jaanus Lass & Maie Bachmann (2021) Threshold of radiofrequency electromagnetic field effect on human brain, International Journal of Radiation Biology, 97:11, 1505-1515, DOI: 10.1080/09553002.2021.1969055

[10] Levitt, B. B., Lai, H. C., & Manville, A. M. (2022b). Effects of non-ionizing electromagnetic fields on flora and fauna, Part 2 impacts: How species interact with natural and man-made EMF. Reviews on Environmental Health, 37(3), 327–406; Thill A, Cammaerts MC, Balmori A. Biological effects of electromagnetic fields on insects: a systematic review and meta-analysis. Rev Environ Health. 2023 Nov 23

[11] See Levitt 2022b

definitions for pollution are in the product protection plans for AT&T, Sprint, Verizon, and T-Mobile. It is standard practice for insurance companies to exclude coverage for such pollutants.[12]

Insurers rank 5G and electromagnetic radiation as a "high" risk,[13] comparing the issue to lead and asbestos.[14] A 2019 Report[15] by Swiss Re Institute, a world leading provider of insurance, classifies 5G mobile networks as a "high", "off-the-leash" risk stating, "Existing concerns regarding potential negative health effects from electromagnetic fields (EMF) are only likely to increase. An uptick in liability claims could be a potential long-term consequence" and "as the biological effects of EMF in general and 5G in particular are still being debated, potential claims for health impairments may come with a long latency."

Wireless Radiofrequency Radiation and the Environment

No agency or international authority has ever acted to review research on wireless radiation effects on the environment nor set environmental exposure limits to ensure protections for birds, bees, trees and wildlife.[16,17] It is a critical regulatory gap.

In 2021 and 2022 a three-part landmark research review by U.S experts of over 1,200 studies on the effects of non-ionizing radiation to wildlife entitled "Effects of non-ionizing electromagnetic fields on flora and fauna" found adverse effects in all species studied, at even very low intensities.[18,19,20]

Numerous studies across all frequencies and taxa indicate that current low-level anthropogenic EMF

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[12] Electromagnetic Field Insurance Policy Exclusions Cell Phone Radiation and EMFs - Environmental Health Trust

[13] https://ehtrust.org/key-issues/reports-white-papers-insurance-industry/

[14] Lloyd's of London Report on Electromagnetic Fields "Electromagnetic fields from mobile phones: recent developments." Lloyd's Emerging Risks Team Report, November 2010; **2016 Austrian Accident Insurance Institute (AUVA) ATHEM Report** "Investigation of athermal effects of electromagnetic fields in mobile communications." ; Business Insurance (2011) **White paper explores risks that could become 'the next asbestos'**
See also Factsheets on Legal Liability of Cell Towers at
https://ehtrust.org/wp-content/uploads/Legal-Liability-Cell-Tower-Radiation-Health-Effects-3.pdf

[15] Swiss Re 5G Report"Off the leash – 5G mobile networks"
https://www.swissre.com/institute/research/sonar/sonar2019/SONAR2019-off-the-leash.html PDF
https://ehtrust.org/wp-content/uploads/Swiss-Re-SONAR-Publication-2019-excerpt-1.pdf

[16] Manville, A. M. (2021). Effects of non-ionizing electromagnetic fields on flora and fauna, Part 3. Exposure standards, public policy, laws, and future directions. Reviews on Environmental Health.

[17] Levitt BB, Lai HC and Manville AM II (2022) Low-level EMF effects on wildlife and plants: What research tells us about an ecosystem approach. Front. Public Health 10:1000840. doi: 10.3389/fpubh.2022.1000840

[18] Levitt, B. B., Lai, H. C., & Manville, A. M. (2021). Effects of non-ionizing electromagnetic fields on flora and fauna, Part 3. Exposure standards, public policy, laws, and future directions. *Reviews on Environmental Health*.

[19] Levitt, B. B., Lai, H. C., & Manville, A. M. (2021). Effects of non-ionizing electromagnetic fields on flora and fauna, part 1. Rising ambient EMF levels in the environment. *Reviews on Environmental Health*, *37*(1), 81–122.

[20] Levitt, B. B., Lai, H. C., & Manville, A. M. (2021). Effects of non-ionizing electromagnetic fields on flora and fauna, Part 2 impacts: How species interact with natural and man-made EMF. *Reviews on Environmental Health*, *37*(3), 327–406.

> can have myriad adverse and synergistic effects, including on orientation and migration, food finding, reproduction, mating, nest and den building, territorial maintenance and defense, and on vitality, longevity and survivorship itself. Effects have been observed in mammals such as bats, cervids, cetaceans, and pinnipeds among others, and on birds, insects, amphibians, reptiles, microbes and many species of flora. Cyto- and geno-toxic effects have long been observed in laboratory research on animal models that can be extrapolated to wildlife.

Wildlife biologists and wireless radiation experts called for a research agenda and protective actions to address wildlife exposures to wireless radiofrequency (RF) radiation in a new article "Addressing Wildlife Exposure to Radiofrequency Electromagnetic Fields: Time for Action[21] published in Environmental Science & Technology Letters. The article highlighted the "unprecedented wildlife exposure to radiofrequency electromagnetic fields" which has "the potential to exert a wide range of biological effects on wildlife, ranging from reduction in bat feeding activity and the alteration of life history characteristics in insects to morphological abnormalities in plants." The researchers highlight how ICNIRP limits (similar to Canadian limits) are exclusively for humans, not wildlife and "are likely to be inadequate in protecting wildlife from RF-induced biological effects because the relationships among RF-EMF exposure, dosage, and outcome are expected to be species-specific; i.e., an RF-EMF exposure that exerts no biological effect in one species could have an effect in another species."

"We also urge the international community to mandate an independent international organization such as the United Nations Environmental Programme or the International Union for Conservation of Nature to address wildlife exposure to RF-EMFs."

The authors then recommend measures to mitigate exposure stating:

> "Pending further evidence, we strongly recommend the implementation of complementary measures aimed at reducing wildlife exposure to RF-EMF, particularly for species of major conservation concern. First, we advocate for strategic spatial planning by aiming the emissions from mobile phone masts away from areas of wildlife conservation significance, such as optimal foraging and nesting sites. Second, emission limitation strategies should be employed, particularly for mobile phone masts that create exposure in these sensitive areas. Third, technical adjustments such as optimizing antenna orientation and installation height and implementing shielding, discouraging, or obstruction mechanisms could further contribute to reducing wildlife exposure to RF-EMF, albeit their effectiveness should first be tested. These measures should ideally be accompanied by a systematic monitoring of wildlife exposure to RF-EMF. Lastly, we suggest integrating an adaptive management approach into these strategies. This approach is adequate to address the uncertainties associated with RF-EMF effects on wildlife by systematically bolstering pertinent knowledge and mitigating risks linked to exposure. This would enable a future in which wireless technologies and wildlife can both flourish.

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[21] Jérémy S. P. Froidevaux, Laura Recuero Virto, Marek Czerwiński, Arno Thielens, and Kirsty J. Park Addressing Wildlife Exposure to Radiofrequency Electromagnetic Fields: Time for ActionEnvironmental Science & Technology Letters

The majority of research has long found harm. In a 2013 review published in *Environment International* on the ecological effects of RF-EMF, 70% of the studies reviewed found RF had a significant effect on birds, insects, other vertebrates, organisms, and plants, with development and reproduction in birds and insects being the most strongly affected.[22]

Dr. Henry Lai, Professor Emeritus at the University of Washington, Editor Emeritus of the journal, Electromagnetic Biology and Medicine, and an emeritus member of the International Commission on the Biological Effects of EMF, has compiled summaries of the research on the biological effects of exposure to radio frequency (RFR) and extremely low frequency (ELF) and static electromagnetic fields (EMF). His new update covers the period from 1990 to January 2024 and finds the preponderance of the research has found that exposure to RFR or ELF EMF produces oxidative effects or free radicals and damages DNA. Moreover the preponderance of studies that examined genetic, neurological and reproductive outcomes has found significant effects.[23] 79% of more than 1,500 studies of RFR reported significant effects. 87% of more than 900 studies of ELF and static fields reported significant effects.

Dr. Lai found the following for radiofrequency radiation:

- 89% (n=316) of 354 RFR oxidative effects (or free radical) studies published since 1997 reported significant effects including 95% (n=82) of 86 studies with a SAR (specific absorption rate) ≤ 0.40 watts per kilogram (which is ten times less than the 4.0 W/kg threshold of harm that the FCC and the ICNIRP use to base their RFR exposure limits).70% (n=328) of 466 RFR genetic effects studies published since 1990 reported significant effects including 79% (n=113) of 144 studies of gene expression.
- 77% (n=333) of 435 RFR neurological studies published since 2007 reported significant effects.
- 83% (n=280) of 335 RFR reproduction and development studies published since 1990 reported significant effects. Among the studies that reported significant effects, 56 studies used an exposure with a SAR ≤ 0.40 W/kg and 37 studies had a SAR ≤ 0.08 W/kg.

Dr. Lai found the following for extremely low frequency (ELF) and static electromagnetic fields

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[22] Cucurachi, S., Tamis, W. L. M., Vijver, M. G., Peijnenburg, W. J. G. M., Bolte, J. F. B., & de Snoo, G. R. (2013). A review of the ecological effects of radiofrequency electromagnetic fields (RF-EMF). *Environment International*, *51*, 116–140.

[23] Links to download each set of abstracts compiled by Dr. Henry Lai. From Effects of Exposure to Electromagnetic Fields: Thirty years of research

- RFR Oxidative Effects studies
- RFR Genetic Effects studies
- RFR Neurological Effects studies
- RFR Reproduction / Development studies
- ELF Oxidative Effects studies
- ELF Genetic Effects studies
- ELF Neurological Effects studies
- ELF Reproduction studies
- List of static / ELF low flux density studies that found effects
- Intermediate Frequency studies

- 91% (n=286) of 316 ELF/static EMF oxidative effects (or free radical) studies published since 1990 reported significant effects.
- 84% (n=288) of 344 ELF/static EMF genetic effects studies published since 1990 reported significant effects including 95% (n=168) of 177 studies of gene expression.91% (n=315) of 345 ELF/static EMF neurological studies published since 2007 reported significant effects.
- 75% (n=65) of 87 ELF/static EMF reproduction and development studies published since 1990 reported significant effects.

Pollinators at Risk

Biologists caution that non ionizing electromagnetic radiation is a critical factor in the decline of pollinator and insect populations.[24]

A 2023 systematic review and meta-analysis of studies on the biological effects on insects of non-ionizing electromagnetic fields, including cell tower and Wi-Fi radiation, was published in the journal Reviews on Environmental Health, finding the "vast majority of studies found effects, generally harmful ones" with toxic effects such as impacts to reproduction and immune health occurring at legally allowed exposure levels. [25]

Higher Exposures to Insects From 5G and Higher Frequencies Used in New Technology

5G and new networks will use wireless carrier frequencies already in use, *but will also use higher frequencies* which have never been used before so widespread in commercial networks. Scientific modeling of the higher frequency 5G wireless exposure to insects has found that these higher frequencies uniquely interact with the smaller bodies of insects to result in significantly higher exposures. Such overexposure could lead to over heating and other serious impacts to pollinators.

Here are some of the published scientific studies on the issue.

- The study "Exposure of Insects to Radio-Frequency Electromagnetic Fields from 2 to 120 GHz" by Thielens et al 2018 published in Scientific Reports found that for the 4 insects studied (western honeybee, australian stingless bee, beetle, locust), exposure at and above 6 GHz could lead to an increase in absorbed power between 3–370% (a factor of over 3 times.) The researchers concluded that "this could lead to changes in insect behavior, physiology, and morphology over time…"

[24] Balmori A. (2021) Electromagnetic radiation as an emerging driver factor for the decline of insects. Science of the Total Environment. 767: 144913

[25] Thill A, Cammaerts MC, Balmori A. Biological effects of electromagnetic fields on insects: a systematic review and meta-analysis. Rev Environ Health. 2023 Nov 23

- A follow up study on the honeybee entitled "Radio-Frequency Electromagnetic Field Exposure of Western Honey Bees" published in Scientific Reports by Thielens et al (2020) modeled exposure in various life cycle stages (worker, drone, larva, and queen) and combined the data with in-situ measurements of environmental RF-EMF exposure near beehives in Belgium in order to estimate realistic exposure and absorbed power values. Again, they found even a relatively small shift of 10% of environmental incident power density from frequencies below 3 GHz to higher frequencies will lead to a relative increase in absorbed power of a factor higher than 3.

- In a subsequent study, researchers modeled the exposures of 2.5 to 100 GHz into the honeybee brain and vital organs in Estimation of the Specific Absorption Rate for a Honey bee Exposed to Radiofrequency Electromagnetic Fields from 2.5 to 100 GHz," by Jeladze et al (2023) and found relatively higher SAR values are observed at 12, 25, and 40 [GHz] frequencies in the 4.8 - 8 W/Kg range, especially for the brain tissue. The SAR values varied depending on exposure parameters such as the direction of the incident plane wave, polarization, frequency, and body peculiarities. The authors conclude that, *"based on the obtained results, we can conclude that the exposure to high-frequency RF-EMFs on honey bees might have an undesired impact, which can cause an attenuation of the vital functions of this important insect."*

- "Radio-frequency exposure of the yellow fever mosquito (A. aegypti) from 2 to 240 GHz," published in PLOS Computational Biology, which found that for the given incident RF power, the absorption increases with increasing frequency between 2 and 90 GHz with a maximum between 90 and 240 GHz. Even at the same incident field strength, the power absorption by the mosquito is 16 times higher at 60 GHz than at 6 GHz.
  For 120 GHz, this increase is even larger compared to 6 GHz, with a factor 21.8. The absorption was highest in the region where the wavelength matches the size of the mosquito. The authors conclude that, "In the future, the carrier frequency of telecommunication systems will also be higher than 6 GHz. This will be paired with higher absorption of EMF by yellow fever mosquitoes, which can cause dielectric heating and have an impact on behavior, development and possibly spread of the insect."

Impacts on Plants

A 2017 review "Weak radiofrequency radiation exposure from mobile phone radiation on plants" found physiological and/or morphological effects in 89.9% of studies reviewed.[26]

> "Additionally, our analysis of the results from these reported studies demonstrates that the maize, roselle, pea, fenugreek, duckweeds, tomato, onions and mungbean plants seem to be very sensitive to

[26] Halgamuge, M. N. (2017). Review: Weak radiofrequency radiation exposure from mobile phone radiation on plants. *Electromagnetic Biology and Medicine*, *36*(2), 213–235

RF-EMFs. Our findings also suggest that plants seem to be more responsive to certain frequencies, especially the frequencies between (i) 800 and 1500 MHz ($p < 0.0001$), (ii) 1500 and 2400 MHz ($p < 0.0001$) and (iii) 3500 and 8000 MHz ($p = 0.0161$)."

Trees are also at risk from wireless. A field monitoring study spanning nine years involving over 100 trees found damage on the side of the trees facing transmitting cell antennas.[27] Researchers have released subsequent reports documenting continued impacts to tree canopy from cell tower antennas.[28,29] Other RF effects documented include impacts to leaf, shoot, seedlings of Aspen trees. [30]

A Lack of Safety Data for New Technology

New technologies such as 5G are introducing and proliferating higher frequencies into the environment. Few research studies have been done on the biological impacts of mid and high band 5G technology. However several individual studies investigating 5G frequencies have found adverse effects. For example:

- An Oregon State University study on zebrafish exposed to the 5G frequency of 3.5 GHz found "significant abnormal responses in RFR-exposed fish" which "suggest potential long-term behavioral effects. Yang et al 2022 found 3.5 GHZ induced oxidative stress in guinea pigs.
- The study "Effects of 700 and 3500 MHz 5G radiofrequency exposure on developing zebrafish embryos" published in Science of the Total Environment found "specific organ morphological effects, and behavioral effects in activity, anxiety-like behavior, and habituation that lasted in larvae exposed during the early embryonic period."
- Male rats exposed to a 5G base station (4 months) that transmitted at 3.6 GHz, 28 GHz, and 36 GHz had moderately increased stress on neuroendocrine system (Perov et al 2022).
- A study on 3.5 GHz exposure to both diabetic and healthy rats (Bektas et al 2022) found an increase in degenerated neurons in the hippocampus of the brains, changes in oxidative stress parameters and changes in the energy metabolism and appetite of both healthy and diabetic rats. The researchers conclude that, "5G may not be innocent in terms of its biological effects, especially in the presence of diabetes."

U.S Federal Lawsuit Centers on Environmental Impacts

The issue of environmental impacts has been at the center of a landmark federal case in the United States,

[27] Waldmann-Selsam, C., Balmori-de la Puente, A., Breunig, H., & Balmori, A. (2016). Radiofrequency radiation injures trees around mobile phone base stations. *Science of The Total Environment*, *572*, 554–569.
[28] Breunig, Helmut. "Tree Damage Caused By Mobile Phone Base Stations An Observation Guide." (2017).
[29] 2021 Report "Tree damage caused by mobile phone base stations"
[30] Haggerty, K. (2010). Adverse Influence of Radio Frequency Background on Trembling Aspen Seedlings: Preliminary Observations. *International Journal of Forestry Research*, *2010*, 836278.

where U.S. FCC limits are similar to Canada's human exposure limits. On August 13, 2021, the United States, Court of Appeals for the District of Columbia Circuit ruled in our case against the FCC (*EHT et al. v FCC*),[31] stating "we find the Commission's order arbitrary and capricious in its complete failure to respond to comments concerning environmental harm caused by RF radiation." Thousands of pages of scientific evidence had been submitted to the FCC finding adverse effects at levels well below FCC limits, including impacts to flora and fauna, yet the FCC had ignored it. The Commission was specifically found to have "completely failed even to acknowledge, let alone respond to, comments concerning the impact of RF radiation on the environment. That utter lack of a response does not meet the Commission's obligation to provide a reasoned explanation for terminating the notice of inquiry."[32]
The court concluded their decision with a mandate to the FCC:

"It must, in particular,

1. provide a reasoned explanation for its decision to retain its testing procedures for determining whether cell phones and other portable electronic devices comply with its guidelines,
2. address the impacts of RF radiation
    - on children,
    - the health implications of long-term exposure to RF radiation,
    - the ubiquity of wireless devices, and other technological developments that have occurred since the Commission last updated its guidelines,
3. and address the impacts of RF radiation on the environment."

It has been over two years and the FCC has not responded. Thus, the FCC's 1996 limits cannot be said to rest on an up to date scientific review and certainly cannot be considered to rest on any review of the science on environmental impacts.

As an example of key information the FCC ignored, the U.S., the Department of Interior wrote a letter to the National Telecommunications and Information Administration (NTIA) detailing several published studies showing impacts of wireless radiofrequency radiation (RFR) to birds stating that, "There is a growing level of anecdotal evidence linking effects of non-thermal, non-ionizing electromagnetic radiation from communication towers on nesting and roosting wild birds and other wildlife." It further stated, "However, the electromagnetic radiation standards used by the Federal Communications Commission (FCC) continue to be based on thermal heating, a criterion now nearly 30 years out of date and inapplicable today."[33]

Since Canadian radiofrequency guidelines are similar to U.S guidelines in their identification of overheating

[31] Final Court Decision EHT et. al v. the FCC 8/13/2021 https://www.cadc.uscourts.gov/internet/opinions.nsf/FB976465BF00F8BD85258730004EFDF7/$file/20-1025-1910111.pdf

[32] https://www.cadc.uscourts.gov/internet/opinions.nsf/FB976465BF00F8BD85258730004EFDF7/$file/20-1025-1910111.pdf

[33] https://www.ntia.doc.gov/files/ntia/us_doi_comments.pdf

as the adviser effect to protect against, the Department of Interior's statement applies to Canada's regulations as well. Canada's Safety Code 6 was not developed with wildlife in mind.

Radiofrequency Radiation Impacts on Human Health

The scientific evidence[34] is adequate to support strong public health policies to reduce wireless radiation, especially for children and vulnerable populations.

EHT et al. v. FCC the U.S. Court of Appeals for the D.C. Circuit 2021[17] also ruled the FCC ignored scientific evidence on negative health effects from long term wireless radiation exposure at current allowable levels, especially in regards to children, whom the American Academy of Pediatrics states[35] are more vulnerable to wireless radiation. The court ordered the FCC to examine the record evidence regarding long term exposure to children, health effects unrelated to cancer and environmental impacts. To date, the FCC has not responded. This landmark ruling highlights how no federal health agency has reviewed the full body of current research to ensure current safety standards are protective.

The state of New Hampshire commissioned a study on the Environmental and Health Effects of Evolving 5G Technology and issued a final report[36] in 2020 with 15 recommendations including: requiring setbacks of all wireless transmitters from residences, businesses and schools, adopting a statewide position to encourage fiber optics to the premise, acknowledging the need for further studies to outline clinical symptoms related to RF exposure, developing RF safety limits to protect the environment, among other recommendations.

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[34] Davis, D., Birnbaum, L., Ben-Ishai, P., Taylor, H., Sears, M., Butler, T., & Scarato, T. (2023). Wireless technologies, non-ionizing electromagnetic fields and children: Identifying and reducing health risks. *Current Problems in Pediatric and Adolescent Health Care*, *53*(2), 101374. ; Belpomme, D., Hardell, L., Belyaev, I., Burgio, E., & Carpenter, D. O. (2018). Thermal and non-thermal health effects of low intensity non-ionizing radiation: An international perspective. *Environmental Pollution*, *242*, 643–658; Directorate-General for Parliamentary Research Services (European Parliament), & Belpoggi, F. (2021). Health impact of 5G: Current state of knowledge of 5G related carcinogenic and reproductive/developmental hazards as they emerge from epidemiological studies and in vivo experimental studies. Publications Office of the European Union; International Commission on the Biological Effects of Electromagnetic Fields (ICBE-EMF), (2022). Scientific evidence invalidates health assumptions underlying the FCC and ICNIRP exposure limit determinations for radiofrequency radiation: implications for 5G. Environ Health. Oct 18;21(1):92; Miller, A. B., Sears, M. E., Morgan, L. L., Davis, D. L., Hardell, L., Oremus, M., & Soskolne, C. L. (2019). Risks to Health and Well-Being From Radio-Frequency Radiation Emitted by Cell Phones and Other Wireless Devices. *Frontiers in Public Health*, *7*.

[35] AAP Letter to the FCC Chairman calling for the FCC to open up a review of RF guidelines (7/12/2012), AAP Letter to US Representative Dennis Kucinich in Support of the Cell Phone Right to Know Act 12/12/2012, AAP to FCC Commissioner Mignon Clyburn and FDA Commissioner Margaret Hamburg calling for a review of RF guidelines 8/29/2013

[36] https://www.gencourt.state.nh.us/statstudcomm/committees/1474/reports/5G%20final%20report.pdf

A major 2022 review of the existing scientific literature on cell tower radiation and health found associations with radiofrequency sickness, cancer and changes in biochemical parameters.[37] For example, a study published in Electromagnetic Biology and Medicine on people living near cell antennas found significant biochemical changes in the blood. This study evaluated effects in the human blood of individuals living near mobile phone base stations compared with healthy controls living more than 300 meters from a base station. The group living closer to the antennas had statistically significant higher frequency of micronuclei and a rise in lipid peroxidation in their blood; these changes are considered biomarkers predictive of cancer.[38]

According to Dr. Linda Birnbaum, Scientist Emeritus and Former Director of the National Institute of Environmental Health Sciences and National Toxicology Program of the National Institutes of Health, "Aware that the FCC's 1996 limits lacked the underpinning of solid scientific data regarding long term health effects, the FDA requested large-scale studies by the National Toxicology Program (NTP) and in 2018 the NTP studies found clear evidence of an association with cancer in male rats.[39] Additionally, the NTP found heart damage and DNA damage, despite the fact that the animals were carefully exposed to non-heating RFR levels long assumed to be safe. The Ramazzini Institute animal studies[40] used even lower RFR lower exposures to approximate cell tower emissions and also found increases of the same tumor type. The NTP studies were carefully controlled to ensure exposures did not significantly heat the animals. The animal study findings in combination with human studies indicate carcinogenic effects from non heating levels of radiofrequency. Currently, several scientists conclude that the weight of currently available, peer-reviewed evidence supports the conclusion that radiofrequency radiation is a proven human carcinogen.

A review paper on corporate risk entitled "Limiting Liability with Positioning to Minimize Negative Health Effects of Cellular Phone Towers" reviewed the "large and growing body of evidence that human exposure to RFR from cellular phone base stations causes negative health effects." The authors recommend restricting antennas near homes and within 500 meters of schools and hospitals to protect companies from

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[37] A. Balmori (2022). Evidence for a health risk by RF on humans living around mobile phone base stations: From radiofrequency sickness to cancer. *Environ. Res., 214 (2022), Article 113851* https://doi.org/10.1016/j.envres.2022.113851

[38] Zothansiama, Zosangzuali, M., Lalramdinpuii, M., & Jagetia, G. C. (2017). Impact of radiofrequency radiation on DNA damage and antioxidants in peripheral blood lymphocytes of humans residing in the vicinity of mobile phone base stations. *Electromagnetic Biology and Medicine*, *36*(3), 295–305. https://doi.org/10.1080/15368378.2017.1350584.

[39] National Toxicology Program Radiofrequency Radiation https://ntp.niehs.nih.gov/whatwestudy/topics/cellphones/index.html

[40] Falcioni et al., Report of final results regarding brain and heart tumors in Sprague-Dawley rats exposed from prenatal life until natural death to mobile phone radiofrequency field representative of a 1.8 GHz GSM base station environmental emission, Environmental Research, Volume 165, 2018, Pages 496-503 DOI: 10.1016/j.envres.2018.01.037

future liability.[41]

European Parliament requested a research report "Health Impact of 5G" which was released in July 2021 and concluded that commonly used RFR frequencies (450 to 6000 MHz) are probably carcinogenic for humans and clearly affect male fertility with possible adverse effects on the development of embryos, fetuses and newborns.

A study entitled The Effect of Continuous Low-Intensity Exposure to Electromagnetic Fields from Radio Base Stations to Cancer Mortality in Brazil published in the International Journal of Environmental Research and Public Health found higher exposure to cell network arrays linked to higher mortality from all cancer and specifically lung and breast cancer.

Recommendations of Scientists With Expertise in Electromagnetic Radiation

Numerous medical groups have called for policies to reduce children's exposure[42]. For example, the EMF Scientists are over 259 scientists from 41 countries who have peer-reviewed publications on electromagnetic fields who made a 2015 appeal to the United Nations[43] and all member States in the world to encourage the World Health Organization "to exert strong leadership in fostering the development of more protective EMF guidelines, encouraging precautionary measures, and educating the public about health risks, particularly risk to children and fetal development."

> Numerous recent scientific publications have shown that EMF affects living organisms at levels well below most international and national guidelines. Effects include increased cancer risk, cellular stress, increase in harmful free radicals, genetic damages, structural and functional changes of the reproductive system, learning and memory deficits, neurological disorders, and negative impacts on general well-being in humans. Damage goes well beyond the human race, as there is growing evidence of harmful effects to both plant and animal life.

Recommendations of The American Academy of Pediatrics

The American Academy of Pediatrics (AAP) has written several letters to the FCC calling on them to update

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[41] Pearce, J. M. (2020). Limiting liability with positioning to minimize negative health effects of cellular phone towers. *Environmental Research*, *181*, 108845. https://doi.org/10.1016/j.envres.2019.108845.

[42] Reykjavik Iceland Appeal on Wireless in School; Scientist 5G Appeal to the EU(2017) Nicosia Declaration (2017);m the International Society of Doctors for Environment 5G Appeal (2018); 2020 Consensus Statement of UK and International Medical and Scientific Experts and Practitioners on Health Effects of Non-Ionising Radiation.

[43] https://ehtrust.org/wp-content/uploads/European_Journal_on_Oncology_December_2015.International_EMF_Scientist_Appeal-2.pdf and EMF Scientist

wireless safety limits to protect children[44] stating that, "Current FCC standards do not account for the unique vulnerability and use patterns specific to pregnant women and children. It is essential that any new standard for cell phones or other wireless devices be based on protecting the youngest and most vulnerable populations to ensure they are safeguarded throughout their lifetimes."

In response to the National Toxicology Program animal study findings of cancer and DNA damage[45] from cell phone radiation, the AAP also issued the cell phone safety tips specifically for families[46] to reduce exposure to wireless radiation including, "If you plan to watch a movie on your device, download it first, then switch to airplane mode while you watch in order to avoid unnecessary radiation exposure."

The American Academy of Pediatrics states of cell towers[47] that, "An Egyptian study confirmed concerns that living nearby mobile phone base stations increased the risk for developing: Headaches, Memory problems, Dizziness, Depression, Sleep problems"

The World Health Organization (WHO)

There are two entities within the WHO, the WHO International Agency for Research on Cancer (IARC) and the WHO EMF Project and neither of them have reviewed the up to date science for well over a decade.

The WHO/IARC determined RF radiation to be a Class 2 B "possible" carcinogen in 2011. Many WHO EMF working group scientists who participated in the WHO/IARC review in 2011[48] now state the current evidence indicating an association with cancer has significantly increased, and if the evidence were evaluated today,

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[44] The American Academy of Pediatrics Letters to the FCC
https://ehtrust.org/wp-content/uploads/American-Academy-of-Pediatrics-Letters-to-FCC-and-Congress-.pdf
AAP Letter to the FCC Chairman calling for the FCC to open up a review of RF guidelines (7/12/2012)
AAP Letter to US Representative Dennis Kucinich in Support of the Cell Phone Right to Know Act 12/12/2012
AAP to FCC Commissioner Mignon Clyburn and FDA Commissioner Margaret Hamburg calling for a review of RF guidelines 8/29/2013

[45] Cell Phone Radio Frequency Radiation

[46] Cell Phone Radiation & Children's Health: What Parents Need to Know - HealthyChildren.org

[47] Electromagnetic Fields: A Hazard to Your Health? - HealthyChildren.org

[48] IARC Working Group on the Evaluation of Carcinogenic Risks to Humans. (2013). Non-ionizing radiation, Part 2: Radiofrequency electromagnetic fields. *IARC Monographs on the Evaluation of Carcinogenic Risks to Humans*, *102*(Pt 2), 1–460. See also the WHO/IARC 2011 Press Release http://www.iarc.fr/en/media-centre/pr/2011/pdfs/pr208_E.pdf

they conclude RF would be considered a probable, if not fully confirmed human carcinogen.[49] The

[49] WHO/IARC scientists concluding the evidence has significantly increased include Lennart Hardell who published Carlberg, M., & Hardell, L. (2017). Evaluation of Mobile Phone and Cordless Phone Use and Glioma Risk Using the Bradford Hill Viewpoints from 1965 on Association or Causation. BioMed Research International, 2017, 9218486 and Hardell, L., & Carlberg, M. (2019). Comments on the US National Toxicology Program technical reports on toxicology and carcinogenesis study in rats exposed to whole-body radiofrequency radiation at 900 MHz and in mice exposed to whole-body radiofrequency radiation at 1,900 MHz. International Journal of Oncology, 54(1), 111–127;

James Lin in James C. Lin. (2022) Carcinogenesis from chronic exposure to radio-frequency radiation. Front. Public Health, Sec. Radiation and Health. 31 October and Lin J. C. (2023). Incongruities in recently revised radiofrequency exposure guidelines and standards. Environmental research, 222, 115369.

In 2021, Chris Portier PhD, former Director of the U.S. National Center for Environmental Health at the Centres for Disease Control and Prevention in Atlanta and the Director of the Agency for Toxic Substances and Disease Registry submitted a comprehensive review of the scientific research in a major cell phone/brain cancer lawsuit where he concludes that "The evidence on an association between cellular phone use and the risk of glioma in adults is quite strong" and "In my opinion, RF exposure probably causes gliomas and neuromas and, given the human, animal and experimental evidence, I assert that, to a reasonable degree of scientific certainty, the probability that RF exposure causes gliomas and neuromas is high."
https://ehtrust.org/wp-content/uploads/Expert-report-Christopher-J-Portier-Murray-v-Motorola-3-1-2021-1.pdf

Dariusz Leszczynski PhD stated in his 2015 lecture to officials in Serbia, "In my opinion, the currently available scientific evidence is sufficient to upgrade the carcinogenicity of cell phone radiation from the possible carcinogen (Group 2B) to the probable carcinogen (Group 2A)"
https://betweenrockandhardplace.files.wordpress.com/2015/10/wireless-communication-and-health-future-of-the-research.pdf

Igor Belyaev PhD states, "The NTP findings along with recent replicated animal studies from Germany [47], supplemented other studies and provided sufficient evidence for carcinogenicity of mobile phone exposure in animals. Studies with chronic exposures have also provided evidence for possible mechanisms of MW effects, which involve production of reactive oxygen/nitrogene species. Taking into account the evidence from human epidemiological studies, MW exposure from mobile phones was suggested to be classified as human carcinogen according to the generally accepted Bradford Hill criteria" in Belyaev, I. (2019). Main Regularities and Health Risks from Exposure to Non-Thermal Microwaves of Mobile Communication. 2019 14th International Conference on Advanced Technologies, Systems and Services in Telecommunications (TELSIKS), 111–116.

Ronald Melnick PhD states "The NTP studies show that the assumption that RF radiation is incapable of causing cancer or other adverse health effects other than by tissue heating is wrong." Melnick, R. (2020). Regarding ICNIRP'S Evaluation of the National Toxicology Program's Carcinogenicity Studies on Radiofrequency Electromagnetic Fields. Health Physics, 118(6), 678–682.

Anthony Miller MD was a reviewer to the WHO/IARC monograph and co-authored Miller, A. B., Morgan, L. L., Udasin, I., & Davis, D. L. (2018). Cancer epidemiology update, following the 2011 IARC evaluation of radiofrequency electromagnetic fields (Monograph 102). *Environmental Research*, *167*, 673–683.

WHO/IARC has not convened an expert group of scientists to review the scientific evidence since 2011 but the WHO/IARC advisory committee has recommended[50] the science on RF radiation be re-evaluated by a scientific working group as "high priority" due to the new research.

The other WHO entity called the WHO EMF Project has not reviewed the science since 1993[51] despite its short webpages on cell phones and cell towers that inaccurately offer safety assurances. The statements on the WHO EMF Project website pages are not based on any current WHO research review (as there has been no review since 1993). An industry funded scientist, now wireless industry consultant[52] claimed authorship of these webpages.[53]

5G Is Increasing Energy Consumption

According to IEEE Magazine, 5G base stations are expected to consume roughly 3 times the power of 4G base stations and more 5G base stations are required to cover the same area.[54] Energy consumption is expected to increase by 61 times from 2020 to 2030 with 5G.[55] This will add more strain on electric grids, especially when we have not fully moved to renewable energy and will further exacerbate carbon emissions.

According to countries that have already installed fiber to the homes (FTTH), like China and Spain, fiber is 85% more energy efficient than copper yielding a saving of 208GWh which represents a reduction of 56,500

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[50] WHO Report of the Advisory Group to Recommend Priorities for the IARC Monographs https://monographs.iarc.who.int/wp-content/uploads/2019/10/IARCMonographs-AGReport-Priorities_2020-2024.pdf

[51] WHO lists its reports including Environmental Health Criteria 137 (1993): Electromagnetic Fields (300 Hz - 300 GHz) which addresses RF

[52] Michael Repacholi stated that he wrote the WHO web pages . Repacholi also arranged for large part of the WHO EMF project to be financed by the telecommunication industry's lobbying organisations" ;"Repacholi acted like a representative for the telecom industry while responsible for the EMF health effects department at the WHO (http://microwavenews.com/news/time-stop-who-charade). Since he left WHO in 2006 he has been involved in industry propaganda video interviews with GSM Association and Hydro Quebec (https://www.youtube.com/watch?v=fDZx7MphDjQ; https://www.youtube.com/watch?v=1MI_fa5YsgY) where he clearly speaks in favor of the telecommunications and the power industries, respectively."

[53]Michael Repacholi stated he wrote some of WHO online webpage factsheets in his speech in a meeting in India, hosted by the Cellular Operators of India stating, "WHO came out with a factsheet stating very clearly mobile phones do not cause cancer, it has not been established…" https://youtu.be/YGbibsFL1dA?si=Rkrw1OkOj4RN3mXF&t=18; He then later says in the Q and A how "I worked for 12 years…getting these uh fact sheets is clear as we could make them and as accurate as we could make them from the science and this they've been accurate now for 10 years" https://www.youtube.com/watch?v=v_KOKMF9Vyg&t=118s

[54] https://spectrum.ieee.org/5gs-waveform-is-a-battery-vampire

[55] https://www.datacenter-forum.com/datacenter-forum/5g-will-prompt-energy-consumption-to-grow-by-staggering-160-in-10-years?fbclid=IwAR0zQ_dGvwT_phdacXuhOkllYOm_p0u95nJAac1toWs4zGUNJnotrvRki7I

tons of CO_2 emissions. One study done by the Federal Environment Ministry of Germany and the German Environment Agency found that video transmission through fiber optics is nearly 50 times more energy efficient than wireless.[56] Research on whole network level assessments of the operational energy use implications of 5G warns "Energy-intensive user practices contribute to ever-growing levels of data traffic, and counteract [57]the energy-saving potential of 5G efficiency improvements."[58] Promoting technology that increases carbon pollution will further exacerbate environmental degradation.

Recommendations to Protect Biodiversity

We recommend environmental agencies develop exposure limits to protect wildlife and their habitat. In order to develop protective limits, relevant agencies must engage in EMF bioeffects research, monitoring, and analysis. The process should be transparent with opportunity for public comment.

Develop Federal Limits to Protect Flora and Fauna

Federal safety limits to protect wildlife should be developed for non-ionizing EMF in both the radiofrequency (RF) range (i.e., for emissions from broadcast, cell towers, 4G, 5G and all government and commercial wireless networks) as well for as extremely low frequency (ELF) ranges (including emissions from power lines and electrical equipment).

EMF limits should be based on an ecosystem approach that considers the interdependent, interconnected relationships of microbiota, plants, and animals. Limits should address:

- Biological impacts from non-thermal (non-heating) exposures
- Biological impacts from not just the power density but also from various characteristics of the exposure including modulation, pulsation, waveform, polarization and signal variability.
- The cumulative impacts from long-term, chronic exposures
- The impacts from EMF synergies with other environmental pollutants

Once EMF limits are set, agencies should conduct ongoing research reviews with periodic updates and opportunities for public comment to ensure regulations are based on up-to-date science.

Ensure Premarket Safety Test Before Deployment

Currently, new technologies are not premarket safety-tested for health effects to humans or impacts to flora and fauna.

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[56] https://www.umweltbundesamt.de/en/press/pressinformation/video-streaming-data-transmission-technology

[57] https://www.etsi.org/images/files/ETSIWhitePapers/WP_47_GFDI.pdf

[58] Williams, Laurence and Sovacool, Benjamin K. and Foxon, Timothy J., The energy use implications of 5G: Reviewing whole network operational energy, embodied energy, and indirect effects (January 13, 2022). Renewable and Sustainable Energy Reviews 157 (2022) 112033, Available at SSRN: https://ssrn.com/abstract=4008530

- All new technologies (modulations, frequencies, and propagation patterns) need to be tested for long term impacts to wildlife and trees/plants before deployment.

Implement Measures to Mitigate Wireless and EMF Exposure Especially in Ecologically Sensitive Areas.

Because developing safety standards for wildlife will take significant time, decisionmakers can take steps now to mitigate risk by reducing environmental exposures especially for endangered, threatened, or species of special concern, and in critical habitats.

Policies to mitigate exposure include:

- Implementing guiding principles of radiation safety based on human radiation safety standards "As Low as Reasonably Achievable" (ALARA) to EMF rather than *all technology and networks wireless all the time*. This is particularly important in urban areas with already high ambient EMF/RFR levels capable of affecting some species that easily co-exist with human populations, as well as in parks and increasingly popular urban forestry practices.
- Conduct regular auditing of EMF levels.
- Create low and no- EMF zones, especially in ecologically sensitive areas.
- Require strategic design modifications to reduce EMF in areas of wildlife conservation. For example, for RF, aiming emissions away from foraging and nesting sites. For ELF, examples include designating where high-tension electric utility corridors can be built or, where already in use, how wire configurations can be modified to eliminate or reduce magnetic fields.
- Maximize the distance between wildlife and EMF sources with barriers or other measures. For example, they could add components to address birds nesting on cell towers and high-tension lines.
- Assess current wireless networks and electrical networks in the country, especially in ecologically sensitive areas and develop a plan to switch to non RF EMF emitting communications systems and mitigate EMF.
- Halt new RFR infrastructure deployments in ecologically sensitive areas such as forests, parks, deserts, and wilderness.
- Halt 5G and sub-millimeter and millimeter wave frequencies to which some species (especially insects) are particularly sensitive.
- Reduce the use of other frequency ranges, if species sensitivities are suspected.

Prioritize Safer Non-Wireless Telecommunications Networks

- Install and promote telecommunications networks that primarily use wired and corded connections because these networks do not emit RF into the environment. The non-wireless connections should go into the home, business or school thereby allowing fast connectivity to the internet without increasing ambient EMF levels.

Ensure Compliance Tests That Consider Wildlife and Habitat (Plants and Trees)

Compliance test procedures must be updated to consider flora and fauna. Currently, cell tower companies show compliance for the wireless radiation RF emissions from their cell towers by measuring the RF radiation at ground level (where people would be walking) or at the nearest walking surface on a building (e.g., a rooftop) and then comparing the measured radiation levels to federal limits for allowable exposures.

The current human-centric procedure ignores fauna who fly, perch and nest near or even directly on cell tower antennas. Similarly, 5G wireless antennas are deployed on poles directly next to trees without any consideration of the impact to the trees from the radiation beams of the antenna.

Cell towers emit levels of RF radiation that often exceed government limits for several feet (sometimes over 100 feet) from the tower, yet the tower is considered compliant because the levels on the ground remain within limits. This is a significant regulatory loophole.

- Compliance test procedures must include areas of wildlife habitat near, or at, the antennas, not just in areas where humans live. Birds, bats and insects that fly, for example, often experience exposures far greater than humans.

Ensure Adequate Oversight and Compliance Programs

- Agencies should create a robust oversight and compliance program to ensure compliance of EMF-emitting infrastructure including cell towers, wireless 5G facilities, transmission lines, and associated electrical equipment.
- Staff and resources should be dedicated to the oversight and enforcement program with a publicly accessible website documenting agency actions.

Ensure Nationwide Monitoring of EMF levels

- Environment and Climate Change Canada should launch a nationwide RF monitoring system including in forests, parks and ecologically sensitive areas in addition to rural and urban areas in order to monitor EMF levels and track wildlife impacts. Data should be easily accessible viaan online map.
- Canada should create a federal registry for all wireless facilities – broadcast, cell tower base stations (3G, 4G, 5G), and small cell network antennas. Much of Europe has already done this.

Ensure Pre - Deployment Environmental Consultation and Assessment

- Federal agencies should conduct full environmental reviews prior to the licensing and national buildout of new networks and new technologies like 5G, 6G and beyond.

- The relevant federal, state and local agencies related to natural resources should be consulted on proposed networks and deployment of wireless facilities as well as lower frequency EMFs and submit recommendations on protecting sensitive species. The biological impactsof EMFs should be considered in the consultation.
- Installations of cell towers and wireless networks near ecologically sensitive areas, conservation areas, wildlife protected areas, important bird habitat, turtle breeding areas, bee colonies, zoos, etc. should be studied for environmental impacts before permitting.
- Public consultation should be mandatory.

Ensure Post-Market Environmental Monitoring and Surveillance

- Agencies should monitor environmental impacts on a regular basis after deployment of networks.
- Agencies should create a public reporting system for environmental impacts from EMF.

Environmental Health Trust has developed two websites: wirelessenviroimpacts.science/ a collaboration with Prevent Cancer Now and Canadians for Safe Technology and other experts and wildlifeandwireless.org.

WILDLIFE AND WIRELESS: POLICY IS NEEDED TO PROTECT FLORA AND FAUNA

Escalating levels of wireless RF* radiation from the proliferation of 4G and 5G telecommunication antennas pose serious risks to wildlife and the natural world. Accumulating research studies have found numerous adverse effects at levels much lower than the U.S. Federal Communication Commission (FCC) legal limits and ICNIRP limits for cell tower emissions.

No Safety Standards

The FCC's federal exposure limits were designed for humans, not wildlife. "Safe" levels of RF exposure for wildlife and plants have never been developed by any scientific or government entity.

Serious Regulatory Gaps

There is no U.S. federal agency measuring or monitoring the current levels of RF in the environment, monitoring the scientific research or gathering data on wildlife impacts from wireless infrastructure.

No Environmental Review

There has been no review of the environmental impact of the 5G infrastructure buildout which the FCC states will require 800,000 new wireless "small" cells.

Higher Exposures

Birds, insects and other airborne species fly, nest and perch close to transmitting antennas. "Small" cells and cell towers emit plumes of RF radiation which can greatly exceed FCC limits, even when measured at distances 10 to sometimes over 40 feet away from the antennas. Yet base station antenna emissions are "legal" because telecom compliance tests *for RF only consider areas inhabited by people*. Wildlife habitat is ignored.

Pollinators at Risk

5G networks will include higher frequencies — submillimeter and millimeter waves — which studies have found uniquely absorb at higher intensities into the bodies of bees and insects. Studies on bees and other insects have long linked cell tower frequencies and EMF exposure to increased stress, decreased honey production, memory impacts, and altered pupal development (Thill et al. 2023).

Damage to Tree Canopy

Trees are being cut down, aggressively trimmed and their roots disturbed to build "small" cell infrastructure. A ten-year field study found damage to trees after years of RF exposure from cell antennas (Waldmann-Selsam et al 2016).

The need for regulatory action is urgent. Immediate steps must be taken to reduce environmental levels of RF and develop safety standards to ensure wildlife and their habitat are protected now and in the future.

"In addition to its impact on humans, radiofrequency radiation poses harmful effects to flora and fauna."

— Natural Resources Defense Council Amicus Brief in EHT et al. v the FCC

*RF = radiofrequency EMF = non-ionizing electromagnetic fields including extremely low frequency

SCIENCE ON FLORA, FAUNA, WIRELESS AND NON-IONIZING RADIATION

The Science is Adequate To Trigger Regulatory Action To Protect Wildlife

A landmark research review on wildlife by U.S experts of over 1,200 studies entitled "Effects of non-ionizing electromagnetic fields on flora and fauna" published in *Reviews on Environmental Health* found adverse effects from EMF* exposure at very low intensities, including impacts to orientation and migration, reproduction, mating, nest, den building and survivorship (Levitt et al., 2021). Effects were found in all species studied.

"A review of the ecological effects of RF-EMF" published in *Environment International* found RF had a significant effect on birds, insects, other vertebrates, other organisms and plants in 70% of the studies. Development and reproduction in birds and insects were strongly affected (Cucurachi et al., 2013).

Scientific evidence indicates that EMFs should be "considered seriously as a complementary driver for the dramatic decline in insects, acting in synergy with agricultural intensification, pesticides, invasive species, and climate change" (Balmori, 2021).

A 2022 Oregon State University study investigated the long-term behavioral effects to zebrafish from short-term exposures to 5G's midband 3.5 GHz. The researchers found "subtle but significant abnormal responses…that suggest potential long-term behavioral effects," and they concluded, "Overall, our study suggests the impacts of RFRs on the developing brain, behavior, and the metabolome should be further explored" (Dasgupta et al., 2022).

U.S. RF Exposure Limits: Unchanged Since 1996

The U.S. has among the most lenient rules regarding allowable RF emissions from cell towers. Many countries, such as Italy, Switzerland, Israel, China, Russia and India, have environmental RF limits 10 to 100 times lower (more stringent). India dropped its RF limits to 1/10th of U.S. limits after an Inter-Ministerial Committee set up by the Ministry of Environment and Forests reviewed the research on birds, bees, plants and animals and found the majority of studies found impacts.

However, none of these countries have safety standards based on science identifying a "safe level" for wildlife and plants.

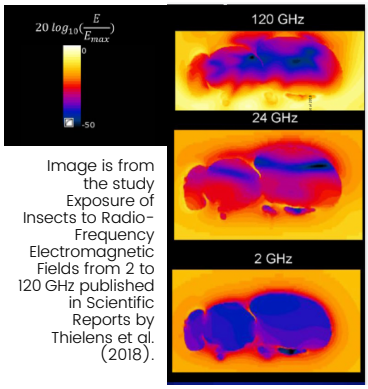


Image is from the study Exposure of Insects to Radio-Frequency Electromagnetic Fields from 2 to 120 GHz published in Scientific Reports by Thielens et al. (2018).

This is an image of the normalized electric field strength (dB) into a Western Honey Bee at various wireless frequencies. It shows that as the wavelengths are higher (as will be used in 5G) the absorption in the bodies of insects also increases, even when the power is the same.

Norway Maple Tree, Damaged by Cell Antennas

Image: Tree Observation Guide by Helmut Breunig 2017 .

"The electromagnetic radiation standards used by the Federal Communications Commission (FCC) continue to be based on thermal heating, a criterion now nearly 30 years out of date and inapplicable today."

— U.S. Department of the Interior 2014 letter detailing studies showing impacts to birds from cell tower radiation.

"The Federal Communications Commission also completely failed even to acknowledge, let alone respond to, comments concerning the impact of RF radiation on the environment."

— U.S. Court of Appeals for the D.C. Circuit Ruling in EHT et al. v. FCC

**RF = radiofrequency EMF = non-ionizing electromagnetic fields including extremely low frequency*

SCIENTIFIC RESEARCH

SCIENTIFIC REVIEWS

Balmori A. (2021) Electromagnetic radiation as an emerging driver factor for the decline of insects. Science of the Total Environment. 767: 144913

Balmori, A. (2015). Anthropogenic radiofrequency electromagnetic fields as an emerging threat to wildlife orientation. Science of The Total Environment, 518–519, 58–60.

Balmori A. (2014). Electrosmog and species conservation. Science of The Total Environment, 496:314-316

Balmori A. (2016) Radiotelemetry and wildlife: Highlighting a gap in the knowledge on radiofrequency radiation effects. Sci Total Environ, Feb 1;543

Cucurachi, S., Tamis, W. L. M., Vijver, M. G., Peijnenburg, W. J. G. M., Bolte, J. F. B., & de Snoo, G. R. (2013). A review of the ecological effects of radiofrequency electromagnetic fields (RF-EMF). Environment International, 51, 116–140.

Halgamuge, M. N. (2017). Review: Weak radiofrequency radiation exposure from mobile phone radiation on plants. Electromagnetic Biology and Medicine, 36(2), 213–235.

Kaur, S., Vian, A., Chandel, S., Singh, D. H., Batish, D., & Kohli, R. (2021). Sensitivity of plants to high frequency electromagnetic radiation: Cellular mechanisms and morphological changes. Reviews in Environmental Science and Bio/Technology, 20.

Levitt BB, Lai HC and Manville AM II (2022) Low-level EMF effects on wildlife and plants: What research tells us about an ecosystem approach. Front. Public Health 10:1000840.

Levitt, B. B., Lai, H. C., & Manville, A. M. (2021). Effects of non-ionizing electromagnetic fields on flora and fauna, part 1. Rising ambient EMF levels in the environment. Reviews on Environmental Health, 37(1), 81–122.

Levitt, B. B., Lai, H. C., & Manville, A. M. (2021). Effects of non-ionizing electromagnetic fields on flora and fauna, Part 2 impacts: How species interact with natural and man-made EMF. Reviews on Environmental Health, 37(3), 327–406.

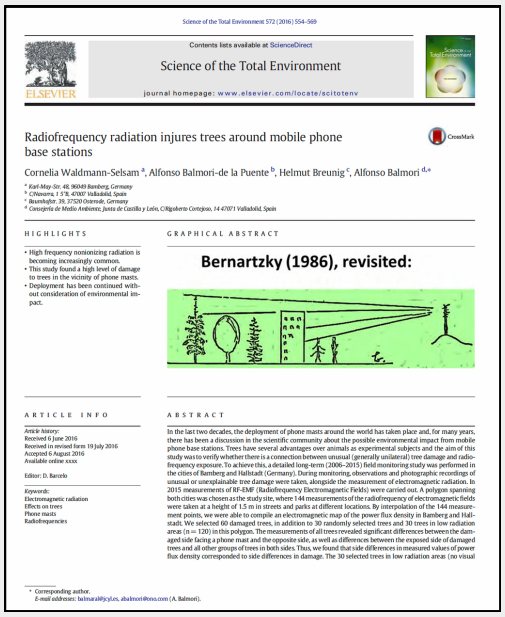
Levitt, B. B., Lai, H. C., & Manville, A. M. (2021). Effects of non-ionizing electromagnetic fields on flora and fauna, Part 3. Exposure standards, public policy, laws, and future directions. Reviews on Environmental Health.

Jérémy S. P. Froidevaux, Laura Recuero Virto, Marek Czerwiński, Arno Thielens, and Kirsty J. Park (2023) Addressing Wildlife Exposure to Radiofrequency Electromagnetic Fields: Time for Action Environmental Science & Technology Letters

Thill A, Cammaerts MC, Balmori A. (2023) Biological effects of electromagnetic fields on insects: a systematic review and meta-analysis. Rev Environ Health, Nov 23

Sivani, S, and D. Sudarsanam. (2012): "Impacts of radio-frequency electromagnetic field (RF-EMF) from cell phone towers and wireless devices on biosystem and ecosystem-a review." Biology and Medicine 4, no. 4 202-216.

"Tree damage caused by mobile phone base stations 2021"



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Radiofrequency radiation injures trees around mobile phone base stations

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HIGHLIGHTS

- High frequency nonionizing radiation is becoming increasingly common.
- This study found a high level of damage to trees in the vicinity of phone masts.
- Deployment has been continued without consideration of environmental impact.

GRAPHICAL ABSTRACT

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ABSTRACT

In the last two decades, the deployment of phone masts around the world has taken place and, for many years, there has been a discussion in the scientific community about the possible environmental impact from mobile phone base stations. Trees have several advantages over animals as experimental subjects and the aim of this study was to verify whether there is a connection between unusual (generally unilateral) tree damage and radiofrequency exposure. To achieve this, a detailed long-term (2006–2015) field monitoring study was performed in the cities of Bamberg and Hailstadt (Germany). During monitoring, observations and photographic recordings of unusual or unexplainable tree damage were taken, alongside the measurement of electromagnetic radiation. In 2015 measurements of RF-EMF (Radiofrequency Electromagnetic Fields) were carried out. A polygon spanning both cities was chosen as the study site, where 144 measurements of the radiofrequency of electromagnetic fields were taken at a height of 1.5 m in streets and parks at different locations. By interpolation of the 144 measurement points, we were able to compile an electromagnetic map of the power flux density in Bamberg and Hailstadt. We selected 60 damaged trees, in addition to 30 randomly selected trees and 30 trees in low radiation areas (n = 120) in this polygon. The measurements of all trees revealed significant differences between the damaged side facing a phone mast and the opposite side, as well as differences between the exposed side of damaged trees and all other groups of trees in both sides. Thus, we found that side differences in measured values of power flux density corresponded to side differences in damage. The 30 selected trees in low radiation areas (no visual

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International Conference on Trees and Electromagnetic Radiation

BEES, WIRELESS & EMFS

Pollinators at Risk

The biodiversity of insects is threatened worldwide. Mounting scientific research indicates that wireless technology and other non-ionizing electromagnetic fields (EMFs) act as a harmful stressor to insects.

An Environmental Pollutant

Cell towers and 4G/5G network antennas emit radiofrequency (RF) radiation and high voltage powerlines emit extremely low frequency (ELF). Both are types of EMF which scientists consider a new type of environmental pollution impacting wildlife.

Ambient levels of these EMFs are increasing in wildlife habitat due to the large-scale proliferation of cell towers, 5G "small" cell towers and electrical equipment in national parks, farmland and ecologically sensitive areas.

Experts Call For Protection

Hundreds of independent scientists are calling for protective policies to reduce environmental EMF exposure due to the growing scientific evidence linking exposure to a range of harmful biological effects.

Defending Pollinators

Government accountability is needed. Outdated EMF regulations were not designed to protect honeybees or wildlife. Environmental agencies should update regulations and EMF mitigation measures are needed in order to safeguard pollinators, especially in ecologically sensitive areas.

SCIENTIFIC RESEARCH: IMPACTS TO BEES EXPOSED TO EMFS

1. Colony Strength
2. Immune System
3. Behavior
4. Homing Ability (ability to come home)

5. Physiology
5. Reproduction & Fertility
6. Queen Bee Egg Laying
7. Orientation

Studies have also found decreased diversity and abundance of insects in areas with higher RF radiation due to the cell tower emissions.

RF = radiofrequency
EMF = non-ionizing electromagnetic fields including RF and ELF

"Electromagnetic radiation should be considered seriously as a complementary driver for the dramatic decline in insects, acting in synergy with agricultural intensification, pesticides, invasive species and climate change."
– Alfonso Balmori (Wildlife Biologist) in "Electromagnetic radiation as an emerging driver factor for the decline of insects" published in *Science of the Total Environment* (2021)

"There is enough evidence to indicate we may be damaging non-human 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."
– Levitt et al. in "*Low-level EMF effects on wildlife and plants*" published in *Frontiers in Public Health* (2023)