



**Minimizing Wireless Radiation* Pollution
for a Healthy Environment**
(*Non-ionizing anthropogenic electromagnetic fields)

RESPONSE TO:

**Discussion Document on the Implementation Framework
for a Right to a Healthy Environment under the
Canadian Environmental Protection Act, 1999 (CEPA)
by Environment and Climate Change Canada and Health Canada**

**Submitted on behalf of Canadians for Safe Technology (C4ST)
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7 April 2024

Re: Response to: “Discussion Document on the Framework Feedback regarding Implementation Framework for a Right to a Healthy Environment under the *Canadian Environmental Protection Act, 1999*” by Environment and Climate Change Canada and Health Canada

**Minimizing Wireless Radiation* Pollution for a Healthy Environment
(*Non-ionizing anthropogenic electromagnetic fields)**

Submitted on behalf of Canadians for Safe Technology (C4ST), as its review of the *Canadian Environmental Protection Act, 1999* (CEPA).

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Canadians for Safe Technology

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Canadians for Safe Technology. Who we are.

Canadians for Safe Technology (C4ST) is a national, not-for-profit, volunteer-based coalition of citizens, including parents and experts. Our mission is to educate and inform Canadians and policy makers about the dangers of exposure to unsafe levels of radiation from technology; and to work with all levels of government to create healthier communities, particularly for children and families.

We welcome the opportunity to provide comments on the Discussion Document on the Implementation of a Right to a Healthy Environment under the *Canadian Environmental Protection Act, 1999* (amended in June 2023).

Responses to questions in the Discussion Document on the Implementation Framework for a Right to a Healthy Environment.

Questions for discussion are inside borders

**Question 1. What does a healthy environment mean to you in the context of the CEPA cycle described in section 2.2 or the issues described in section 3.1?
(Section 3.1 Definition and scope of the right to a healthy environment)**

Question 1, C4ST's comments to ECCC and HC:

CEPA is “An Act respecting pollution prevention and the protection of the environment and human health in order to contribute to sustainable development.” and defines a “healthy environment” as “an environment that is clean, healthy and sustainable.”¹

The scope of the right to a healthy environment encompasses all *substances, pollutants and waste* that may potentially create an unhealthy environment. Thus, “pollutants” are distinct from and not completely covered by “substances” and “waste.”

All life is electrochemical. Every plant, animal and microorganism grows and moves because interactions of electrical fields cause chemical reactions to occur. Communications between living cells consist of electrical and chemical signals. There is increasing concern over non-ionizing **anthropogenic** electromagnetic fields (NIR-EMFs), in the frequencies and modulations found today. Emissions are projected to increase with increasing telecommunications, but, at levels encountered in present day living situations, emissions are interfering with these electrochemical communications that are vital for survival, good health and a healthy environment. Implementation of CEPA puts much emphasis on the chemical aspect of “electrochemical”. It is past due that there be at least as much emphasis dedicated to the “electro” counterpart—the life force of all biota on Earth.

Two ranges in the non-ionizing radiation (NIR) portion of the electromagnetic spectrum are generally recognized as being of concern, as sources and emission levels of electromagnetic fields (EMFs) are increasing rapidly due to proliferation of modern technologies that generate extremely low frequencies (ELFs - background to 3 kHz) and/or radiofrequency/microwave radiation (RF/MW radiation - 3 kHz to 300 GHz; “wireless” radiation). Both ELFs and RF/MW radiation have been shown to affect living organisms at very low exposure levels of NIR-EMF.^{2 3} Although nominal frequencies are ascribed to RF/MW, this radiation as [anthropogenic] NIR-EMFs is often pulsed and modulated and therefore fundamentally different from naturally occurring non-ionizing EMFs.

NIR-EMFs are generated and emitted by wireless equipment such as cell tower antennas, smart utility meters, Wi-Fi devices, cell phones and baby monitors.

It is important to note that “*pollutants*” in the *Canadian Environmental Protection Act* (CEPA) is listed, several times, along with and distinct from toxic substances and wastes. For example, under “*Administrative Duties*.”

¹ CEPA. Definitions. 3 (1)

² Wireless Enviro Impacts: <https://wirelessenviroimpacts.science/zotero-database/>

³ Wildlife, Wireless and the Environment: <https://www.wildlifeandwireless.org/>

Within the implementation framework, it is reasonable and necessary to address pollution of airspace by NIR-EMFs, in particular (1) sources and emission levels of “wireless” radiation that are increasing by many orders of magnitude above natural levels and (2) lower frequency ELF associated with electrical power.

NIR-EMFs fit the air pollution definition in CEPA as set out for “substances” below in this section (see the comments under the green blocks).

Environmental effects of anthropogenic electromagnetic radiation are addressed under CEPA and not in any other federal legislation (Appendix 1).

Furthermore, reference to “Technologies” in the 13th paragraph of the preamble is consistent with CEPA applying to NIR-EMFs that fuel wireless connectivity, despite existence of safer alternative technologies such as fibre-optic cable and other wireline (wired or corded) connections (Appendix 2).

NIR-EMFs have been reported in an Environment and Climate Change Canada report, “*The potential of increasing EMF exposure as a contributing or confounding factor to adverse changes in wildlife, in conjunction with recognized environmental stressors, should be considered*” (Appendix 3).

More recently, the Milestone Interim report for the ECCC 2030 National Biodiversity Strategy makes note of EMFs (Appendix 4). There is also substantial evidence that effects of NIR-EMFs can interact with effects of exposures to substances, including synergistic effects (Appendix 5).

To date, an under-acknowledged pollutant within the scope of CEPA and of this Discussion Document is wireless radiation, i.e., non-ionizing anthropogenic electromagnetic fields (NIR-EMFs). NIR-EMFs must be given at least as much attention as substances, other pollutants and wastes. To have a healthy environment, all risks of wireless radiation (electromagnetic fields, EMFs) must be fully assessed and minimized according to the extent that using wireless is essential, with all points of the CEPA cycle rigorously applied.

Within the implementation, it is reasonable and necessary to address pollution of the airspace by non-ionizing electromagnetic fields (NIR-EMFs), in particular “wireless” radiofrequency radiation, which is increasing by many orders of magnitude, as well as lower frequency NIR-EMFs associated with electrical power.

Substantiation that wireless radiation (non-ionizing anthropogenic electromagnetic fields, NIR-EMFs) is a pollutant

Air pollutants are not necessarily substances. “Pollutants” is mentioned several times in CEPA as being distinct from toxic substances and wastes.

For example: Under “**Administrative Duties**”.

“Duties of the Government of Canada 2 (1) In the administration of this Act, the government of Canada shall, having regard to the Constitution and laws of Canada and subject to subsection (1.1), (j) protect the environment, including its biological diversity, and human health, from the risk of any adverse effects of the use and release of **toxic substances, pollutants and waste:**”

NIR-EMFs satisfy the criteria of air pollution as stated in CEPA in the following ways. Statements from CEPA are in green blocks, followed by comments by C4ST.

Canadian Environmental Protection Act, 1999

The preamble to the CEPA states it is "**An Act respecting pollution prevention and the protection of the environment and human health in order to contribute to sustainable development.**"

Interpretation

Section 3. Definitions

[1] ***air pollution means a condition of the air, arising wholly or partly from the presence in the air of any substance, that directly or indirectly***

C4ST's comments:

Air pollution does not necessarily consist solely of substances. Electromagnetic fields (EMFs) are pervasive in our air. Sources of EMFs in our air space include both extremely low frequencies (ELF) and radiofrequency/microwave (RF/MW) radiation. ELF includes emissions from high power lines and household electricity. RF/MW radiation includes higher frequencies commonly used for wireless communications e.g. cell tower antennas, broadcast towers for radio signals, satellite communications transmissions, radar, smart meters, cell phones, Wi-Fi routers, etc. Although present for many decades, the sources of NIR emissions and levels are escalating rapidly. There are estimates that levels are now trillions of times above historical background levels.⁴

(a) endangers the health, safety or welfare of humans;

C4ST's comments:

Adverse health effects have been documented extensively in the peer-reviewed scientific literature — at population, individual, cell and molecular levels.

For example:

- The World Health Organization, International Agency for Research on Cancer classified wireless radiofrequency/microwave radiation as a Group 2B *possible* human carcinogen in 2011⁵. Scientist and physicians state that newer studies indicate that this classification should be upgraded to a Group 1 *known* human carcinogen.^{6 7}
- The same classification was given to magnetic fields in 2001/2002 (recently reaffirmed) (WHO/IARC, 2001).⁸ There has been a consistent statistically significant association between extremely low frequencies and cancer, including childhood leukemia.⁹

⁴ Bandara, P., & Carpenter, D. O. (2018). **Planetary electromagnetic pollution: it is time to assess its impact.** *The Lancet Planetary Health*, 2(12), e512–e514. [https://doi.org/10.1016/S2542-5196\(18\)30221-3](https://doi.org/10.1016/S2542-5196(18)30221-3)

⁵ Baan, R., Grosse, Y., Lauby-Secretan, B., El Ghissassi, F., Bouvard, V., Benbrahim-Tallaa, L., ... WHO International Agency for **Research on Cancer Monograph Working Group. (2011). Carcinogenicity of radiofrequency electromagnetic fields.** *Lancet Oncology*, 12(7), 624–626. doi:10.1016/S1470-2045(11)70147-4

⁶ Hardell, L., & Carlberg, M. (2018). **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*. <https://doi.org/10.3892/ijo.2018.4606>

⁷ 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). DOI. 10.1016/j.envres.2018.06.043). <https://doi.org/10.1016/j.envres.2018.06.043>

⁸ **WHO/IARC. (2001). Classification of extremely low frequency (ELF) as class 2B (*possible* human carcinogen).** <https://monographs.iarc.who.int/list-of-classifications/>

⁹ Carpenter, David O. "Extremely Low Frequency Electromagnetic Fields and Cancer: How Source of Funding Affects Results."

- Cancer and other risks have also been documented.¹⁰ Children are at particular risk.¹¹
- Cellular and molecular effects are reviewed in this recent publication:
Lai, H., & Levitt, B. B. (2023). **Cellular and molecular effects of non-ionizing electromagnetic fields.** *Reviews on Environmental Health.*
ABSTRACT: *The way that living cells respond to non-ionizing electromagnetic fields (EMF), including static/extremely-low frequency and radiofrequency electromagnetic fields, fits the pattern of ‘cellular stress response’ – a mechanism manifest at the cellular level intended to preserve the entire organism. It is a set pattern of cellular and molecular responses to environmental stressors, such as heat, ionizing radiation, oxidation, etc. It is triggered by cellular macromolecular damage (in proteins, lipids, and DNA) with the goal of repairing and returning cell functions to homeostasis. The pattern is independent of the type of stressor encountered. It involves cell cycle arrest, induction of specific molecular mechanisms for repair, damage removal, cell proliferation, and cell death if damage is too great. This response could be triggered by EMF-induced alternation in oxidative processes in cells. The concept that biological response to EMF is a ‘cellular stress response’ explains many observed effects of EMF, such as nonlinear dose- and time-dependency, increased and decreased risks of cancer and neurodegenerative diseases, enhanced nerve regeneration, and bone healing. These responses could be either detrimental or beneficial to health, depending on the duration and intensity of the exposure, as well as specific aspects of the living organism being exposed. A corollary to electromagnetic hypersensitivity syndrome (EHS) could be an inappropriate response of the hippocampus/limbic system to EMF, involving glucocorticoids on the hypothalamic-pituitary-adrenal axis.* <https://doi.org/10.1515/reveh-2023-0023>

(b) interferes with the normal enjoyment of life or property;

C4ST’s comments:

C4ST is contacted frequently by individuals who are adversely affected by electromagnetic fields in their regular living environment.

- Canadian Human Rights Commission has a policy established in 2007 on accommodation of environmental sensitivities, including symptoms related to low levels of electromagnetic radiation related to technologies.
http://www.chrc-ccdp.gc.ca/sites/default/files/policy_sensitivity_0.pdf
http://www.chrc-ccdp.gc.ca/sites/default/files/envsensitivity_en.pdf
- Dr. Riina Bray, Dr. Magda Havas and Mr. Frank Clegg in their testimony to the Parliamentary Standing Committee on Health in 2015 describe the situation where many Canadians have had their lives disrupted by exposure to EMFs at everyday levels.¹²

Environmental Research 178 (November 1, 2019): 108688. <https://doi.org/10.1016/j.envres.2019.108688>

¹⁰ 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. <https://doi.org/10.3389/fpubh.2019.00223>

¹¹ 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. <https://doi.org/10.1016/j.cppeds.2023.101374>

¹² Lobb, B. (2015b). **Evidence, Hearing 1. Radiofrequency electromagnetic radiation and the health of Canadians Report No. 13 - HESA (41-2) - No. 54 - House of Commons of Canada**, 24.
http://www.parl.gc.ca/content/hoc/Committee/412/HESA/Evidence/EV7892702/HESA_EV54-E.PDF. Retrieved from http://www.parl.gc.ca/content/hoc/Committee/412/HESA/Evidence/EV7892702/HESA_EV54-E.PDF

- A young Canadian woman is reconsidering medically assisted dying after a GoFundMe campaign (2022, June 7). **For a young woman with acute environmental hypersensitivity, applying to government authorities for assistance with dying has proved far easier than dealing with the housing bureaucracy.** Retrieved September 5, 2022, from <https://www.americamagazine.org/politics-society/2022/06/07/medically-assisted-dying-canada-disability-243049>
- Some Canadians gave testimonials of severe adverse effects to wireless radiation that affected their everyday quality of life:
 1. Royal Society of Canada public consultation October 28th, 2013 and
 2. Health Canada, July 9th, 2014, (contact Frank Clegg¹³ for details).
- Sweden recognizes electrosensitivity as a functional impairment (Johansson, 2015). Johansson, O. (2015). **Electrohypersensitivity: a functional impairment due to an inaccessible environment.** *Reviews on Environmental Health*, 30(4), 311–321.
ABSTRACT: IN Sweden, electrohypersensitivity is recognized as a functional impairment which implies only the environment as the culprit. The Swedish view provides persons with this impairment a maximal legal protection, it gives them the right to get accessibility measures for free, as well as governmental subsidies and municipality economic support, and to provide them with special Ombudsmen (at the municipality, the EU, and the UN level, respectively), the right and economic means to form disability organizations and allow these to be part of national and international counterparts, all with the simple and single aim to allow persons with the functional impairment electrohypersensitivity to live an equal life in a society based on equality. They are not seen as patients, they do not have an overriding medical diagnosis, but the “patient” is only the inferior and potentially toxic environment. This does not mean that a subjective symptom of a functionally impaired can not be treated by a physician, as well as get sick-leave from their workplace as well as economic compensation, and already in the year 2000 such symptoms were identified in the Internal Code of Diagnoses, version 10 (ICD-10; R68.8/nor W90), and have been since. But the underlying cause still remains only the environment. <https://doi.org/10.1515/reveh-2015-0018>
- Spain has legally recognized electrosensitivity
<https://beingelectrosensitive.blogspot.ca/2016/08/spain-ehs-legally-recognised.html>
- Dr. Gro Harlem Brundtland former Prime Minister of Norway, former Director of the World Health Organization and lead author of the Brundtland Report, *Our Common Future*, which inspired the sustainable development movement, is among those who report symptoms, e.g. headaches, from cell phone use.
<http://www.magdahavas.com/gro-harlem-brundtland-talks-at-the-university-of-waterloo/>

Lobb, B. (2015c). **Evidence, Hearing 2. Radiofrequency electromagnetic radiation and the health of Canadians Report No. 13 - HESA (41-2) - No. 57 - House of Commons of Canada**, 19.

http://www.parl.gc.ca/content/hoc/Committee/412/HESA/Evidence/EV7936469/HESA_EV57-E.PDF. Retrieved from http://www.parl.gc.ca/content/hoc/Committee/412/HESA/Evidence/EV7936469/HESA_EV57-E.PDF

Lobb, B. (2015d). **Evidence, Hearing 3. Radiofrequency electromagnetic radiation and the health of Canadians Report No. 13 - HESA (41-2) - No. 58 - House of Commons of Canada**, 19.

http://www.parl.gc.ca/content/hoc/Committee/412/HESA/Evidence/EV7945128/HESA_EV58-E.PDF. Retrieved from http://www.parl.gc.ca/content/hoc/Committee/412/HESA/Evidence/EV7945128/HESA_EV58-E.PDF

Lobb, B. (2015e). **Report: Radiofrequency electromagnetic radiation and the health of Canadians Report No. 13 - HESA (41-2) - No. 13 - House of Commons of Canada**, 42. <https://www.ourcommons.ca/DocumentViewer/en/41-2/HESA/report-13/>. Retrieved from <https://www.ourcommons.ca/DocumentViewer/en/41-2/HESA/report-13/>

¹³ Frank Clegg email: frank@c4st.org

- Dr. Dominique Belpomme of France is one of several medical professionals who have documented biomarkers in humans for electrosensitivity.
Belpomme, D., Carlo, G. L., Irigaray, P., Carpenter, D. O., Hardell, L., Kundi, M., ... Vorst, A. V. (2021). **The Critical Importance of Molecular Biomarkers and Imaging in the Study of Electrohypersensitivity. A Scientific Consensus International Report.** *International Journal of Molecular Sciences*, 22(14), 7321.
ABSTRACT: Clinical research aiming at objectively identifying and characterizing diseases via clinical observations and biological and radiological findings is a critical initial research step when establishing objective diagnostic criteria and treatments. Failure to first define such diagnostic criteria may lead research on pathogenesis and etiology to serious confounding biases and erroneous medical interpretations. This is particularly the case for electrohypersensitivity (EHS) and more particularly for the so-called “provocation tests”, which do not investigate the causal origin of EHS but rather the EHS-associated particular environmental intolerance state with hypersensitivity to man-made electromagnetic fields (EMF). However, because those tests depend on multiple EMF-associated physical and biological parameters and have been conducted in patients without having first defined EHS objectively and/or endpoints adequately, they cannot presently be considered to be valid pathogenesis research methodologies. Consequently, the negative results obtained by these tests do not preclude a role of EMF exposure as a symptomatic trigger in EHS patients. Moreover, there is no proof that EHS symptoms or EHS itself are caused by psychosomatic or placebo effects. This international consensus report pleads for the acknowledgement of EHS as a distinct neuropathological disorder and for its inclusion in the WHO International Classification of Diseases. <https://doi.org/10.3390/ijms22147321>
- World Health Organization – International Classification of Diseases (ICD) has a code for adverse health effects from non-ionizing radiofrequency radiation. <https://icd.codes/icd10cm/W90>
- More information can be found at: *EUROPAEM EMF Guideline 2016 for the Prevention, Diagnosis and Treatment of EMF-related Health Problems and Illnesses*
<https://pubmed.ncbi.nlm.nih.gov/27454111-europaem-emf-guideline-2016-for-the-prevention-diagnosis-and-treatment-of-emf-related-health-problems-and-illnesses/>

(c) endangers the health of animal life;

C4ST’s comments:

The adverse effects on animal life by NIR-EMFs are well documented in the published scientific peer-reviewed literature.

- This recent publication reviews the evidence that NIR-EMFs are linked to the decline of insect populations:
Balmori, Alfonso. (2021). **Electromagnetic radiation as an emerging driver factor for the decline of insects.** *Science of The Total Environment*, 767, 144913.
<https://doi.org/10.1016/j.scitotenv.2020.144913>
- A recent review and meta-analysis examines the above studies and provides additional relevant information:
Thill, A., Cammaerts, M.-C., & Balmori, A. (2023). **Biological effects of electromagnetic fields on insects: a systematic review and meta-analysis.** *Reviews on Environmental Health.*
<https://doi.org/10.1515/reveh-2023-0072>
- Also see this review of the literature on NIR-EMFs and invertebrates, including insects:
Friesen, M., & Havas, M. (2020). **Effects of Non-ionizing Electromagnetic Pollution on Invertebrates,**

Including Pollinators such as Honey Bees: What We Know, What We don't Know, and What We Need to Know. In *Working Landscapes. Proceedings of the 12th Prairie Conservation and Endangered Species Conference*, Danyluk (ed.). February 2019, Winnipeg, Manitoba..203 pages. (pp. 127–138). Critical Wildlife Habitat Program, Winnipeg, Manitoba. Retrieved from <http://pcesc.ca/media/45404/final-2019-pcesc-proceedings.pdf>

Some examples of studies in insect species that support the findings of adverse biological effects reported in bees:

- 1. Atli, E., & Unlü, H.. (2006). The effects of microwave frequency electromagnetic fields on the development of *Drosophila melanogaster*. *International Journal of Radiation Biology*, 82(6), 435–441.**
Extract: "... 10 GHz EMF can cause developmental delay and decrease the number of offspring in *D. melanogaster*."
- 2. Cammaerts, M.-C., De Doncker, P., Patris, X., Bellens, F., Rachidi, Z., & Cammaerts, D. (2012). GSM 900 MHz radiation inhibits ants' association between food sites and encountered cues. *Electromagnetic Biology and Medicine*, 31(2), 151–165.**
Extract: "...They kept no visual memory at all (instead of keeping 10% of it as they normally do). The impact of GSM 900 MHz radiation was greater on the visual memory than on the olfactory one. These communication waves may have such a disastrous impact on a wide range of insects using olfactory and/or visual memory, i.e., on bees."
- 3. Cammaerts, M.-C., & Johansson, O.. (2013). Ants can be used as bio-indicators to reveal biological effects of electromagnetic waves from some wireless apparatus. *Electromagnetic Biology and Medicine*, 1–7.**
Extract: "...we designed and validated a fast and easy test on ants – these insects being used as a biological model – for revealing the effect of wireless equipments like mobile phones, smartphones, digital enhanced cordless telephone (DECT) phones, WiFi routers and so on. This test includes quantification of ants' locomotion under natural conditions, then in the vicinity of such wireless equipments. Observations, numerical results and statistical results allow detecting any effect of a radiating source on these living organisms."
- 4. Cammaerts, M.-C., Rachidi, Z., Bellens, F., & De Doncker, P.. (2013). Food collection and response to pheromones in an ant species exposed to electromagnetic radiation. *Electromagnetic Biology and Medicine*, 32(3), 315–332.**
Extract: "...[Exposed] ants followed trails for only short distances, no longer arrived at marked areas and no longer orientated themselves to a source of alarm pheromone. Also when exposed to electromagnetic waves, ants became unable to return to their nest and recruit congeners; therefore, the number of ants collecting food increases only slightly and slowly. After 180 h of exposure, their colonies deteriorated. Electromagnetic radiation obviously affects social insects' behavior and physiology."
- 5. Margaritis, L. H., Manta, A. K., Kokkaliaris, K. D., Kokkaliaris, C. D., Schiza, D., Alimisis, K., ... Ziomas, K.. (2013). *Drosophila* oogenesis as a bio-marker responding to EMF sources. *Electromagnetic Biology and Medicine*.**
Extract: "A total of 280 different experiments were performed... All EMF sources used created statistically significant effects regarding fecundity and cell death-apoptosis induction, even at very low intensity levels (0.3 V/m blue tooth radiation), well below ICNIRP's guidelines, suggesting that *Drosophila* oogenesis system is suitable to be used as a biomarker for exploring potential EMF bioactivity."
- 6. Panagopoulos, D. J.. (2012). Effect of microwave exposure on the ovarian development of *Drosophila melanogaster*. *Cell Biochemistry and Biophysics*, 63(2), 121–132.**
Extract: "The study showed that the ovarian size of the exposed insects is significantly smaller than that of the corresponding sham-exposed insects, due to destruction of egg chambers by the GSM"

radiation, after DNA damage and consequent cell death induction in the egg chamber cells of the virgin females as shown in previous experiments on inseminated females."

A particularly rigorous, well designed bird study by Dr. Engels' team in Germany demonstrated that the orientation of the European robin was disrupted by ambient AM radiofrequency signals at non-thermal conditions.

Engels, S., Schneider, N.-L., Lefeldt, N., Hein, C. M., Zapka, M., Michalik, A., ... Mouritsen, H.. (2014). **Anthropogenic electromagnetic noise disrupts magnetic compass orientation in a migratory bird.** *Nature*, **509(7500)**, 353–356.

Extract: "...we show that migratory birds are unable to use their magnetic compass in the presence of urban electromagnetic noise... These fully double-blinded tests document a reproducible effect of anthropogenic electromagnetic noise on the behaviour of an intact vertebrate."

This was followed up with another study: Schwarze, S., Schneider, N.-L., Reichl, T., Dreyer, D., Lefeldt, N., Engels, S., ... Mouritsen, H. (2016). **Weak Broadband Electromagnetic Fields are More Disruptive to Magnetic Compass Orientation in a Night-Migratory Songbird (*Erithacus rubecula*) than Strong Narrow-Band Fields.** *Frontiers in Behavioral Neuroscience*, *10*, 55.

Extract: *Magnetic compass orientation in night-migratory songbirds is embedded in the visual system and seems to be based on a light-dependent radical pair mechanism. Recent findings suggest that both broadband electromagnetic fields ranging from ~2 kHz to ~9 MHz and narrow-band fields at the so-called Larmor frequency for a free electron in the Earth's magnetic field can disrupt this mechanism.... Our results indicated that the magnetic compass orientation of European robins ... the weak broadband field very efficiently disrupted their orientation.* <https://doi.org/10.3389/fnbeh.2016.00055>

Concerns, particularly with regard to migratory birds, are outlined by Mr. Willie Taylor, Director, Office of Environmental Policy and Compliance, United States Department of Interior to Mr. Eli Veenendaal of the US Department of Commerce.

https://www.ntia.doc.gov/files/ntia/us_doi_comments.pdf

https://doi_dev.opengov.ibmcloud.com/oepc/director-office/taylor

(d) causes damage to plant life or to property; or

C4ST's comments:

Damage to plant life by electromagnetic fields is well documented in the published scientific peer-reviewed literature.

Also see the review by Halgamuge (2016). **Halgamuge, M. N. (2016). Review: Weak radiofrequency radiation exposure from mobile phone radiation on plants.** ResearchGate, 1–23. doi:10.1080/15368378.2016.1220389

One example:

Waldmann-Selsam, C., Balmori-de la Puente, A., Breunig, H., & Balmori, A. (2016). Radiofrequency radiation injures trees around mobile phone base stations. *The Science of the Total Environment*, *572*, 554–569

Extract: "*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... These results are consistent with the fact that damage afflicted on trees by mobile phone towers usually start on one side, extending to the whole tree over time.*"

(e) degrades or alters, or forms part of a process of degradation or alteration of, an ecosystem to an extent that is detrimental to its use by humans, animals or plants.

C4ST's comments:

Damage to humans, other animals and plants by NIR-EMFs is well documented in the published scientific peer-reviewed literature. One of many examples is that of bees. Declining numbers of pollinators alone are having large impacts on some ecosystems. Effects of on some pollinators, supported by similar findings in other insects, indicate that EMFs may be a significant, or even substantial contributing factor in the decline in abundance.

- Levitt, B. B., Lai, H. C., & Manville, A. M. (2022). **Low-level EMF effects on wildlife and plants: What research tells us about an ecosystem approach.** *Frontiers in Public Health*, 10. Retrieved from <https://www.frontiersin.org/articles/10.3389/fpubh.2022.1000840>
Extract: "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".

In the above paper, the authors have drawn on their three-part review which provides extensive evidence of harm from NIR-EMFs as well as suggestions for improvements to public policy and laws.

- Levitt, B. B., Lai, H. C., & Manville, A. M. (2021a). **Effects of non-ionizing electromagnetic fields on flora and fauna, Part 1. Rising ambient EMF levels in the environment.** *Reviews on Environmental Health*. <https://doi.org/10.1515/reveh-2021-0026>
- Levitt, B. B., Lai, H. C., & Manville, A. M. (2021b). **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*. <https://doi.org/10.1515/reveh-2021-0050>
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Question 2. How would you know if your environment is healthy?

(Section as above in Question 1.)

Question 2, C4ST's comments to ECCC:

There would be high biodiversity, robust populations of top predators and a non-contaminated environment, along with true sustainable development that would ensure the needs of future generations would be met. There would be no species on the Species at Risk Act lists.

Question 2, C4ST's comments to HC:

No environmentally-linked diseases.

Question 3. How would you see these factors to limit the consideration of the right being taken into account when making decisions under CEPA?

(Section 3.1.1 Reasonable limits)

Question 3, C4ST's comments to ECCC and HC:

This is a complex question which, as the discussion paper states, includes consideration of factors including social, health, scientific and economic factors. It would be helpful to have some real examples as well as possible scenarios included in the next draft for the public to comment on.

The reasons for suspension of the right to a healthy environment would have to be extraordinary, such as a threat to national security.

It is possible to imagine that choices would have to be made to favour, for example, upland versus wetland species, in the case of wetland restoration.

Question 4. Are any of these principles and the way in which they can contribute to the protection of the right to a healthy environment under CEPA unclear?

(Section 3.2 Principles

3.2.1 Environmental justice

3.2.2 Non-regression

3.2.3 Intergenerational equity

Examples of mechanisms within CEPA and potential opportunities)

Question 4, C4ST's comments to ECCC and HC:

The Guiding Principles for CEPA (outlined in the Discussion Document) of sustainable development, pollution prevention, ecosystem approach, precautionary principle, Intergovernmental cooperation, national standards, polluter pays and science-based decision-making, as well as those outlined in this section (environmental justice, non-regression and intergenerational equity), all contribute positively towards achieving a healthy environment.

The general goals are clear enough but success depends on how this is implemented.

Some examples of how this has already been applied to substances, pollutants and wastes would be helpful. The goals seem clear; however the mechanisms and methods for scientific assessment and regulation are absent.

Question 5. Are there other opportunities within the CEPA management cycle to consider these principles and strengthen the protection of the right?

(Section as above for Question 4.)

Question 5, C4ST's comments to ECCC:

NIR-EMFs must first be assessed by ECCC to establish biologically based exposure limits, and regulated to protect biota. Associated data should be collected and made available through a government data portal, to support scientific rationale and to provide data for evidence-based healthier options to provide telecommunications in Canada.

Figure 1 illustrates some of the biological effects that low levels of NIR-EMFs can have on biota. Current Health Canada guidelines for humans do not adequately protect non-human species including wildlife, e.g., pollinators. Evidence-based regulation of NIR-EMFs to protect diverse species needs to be prioritized if we are to have a healthy environment and meet biodiversity goals. Minimizing wireless pollution to minimize adverse biological effects needs to be made a high priority in the CEPA cycle.

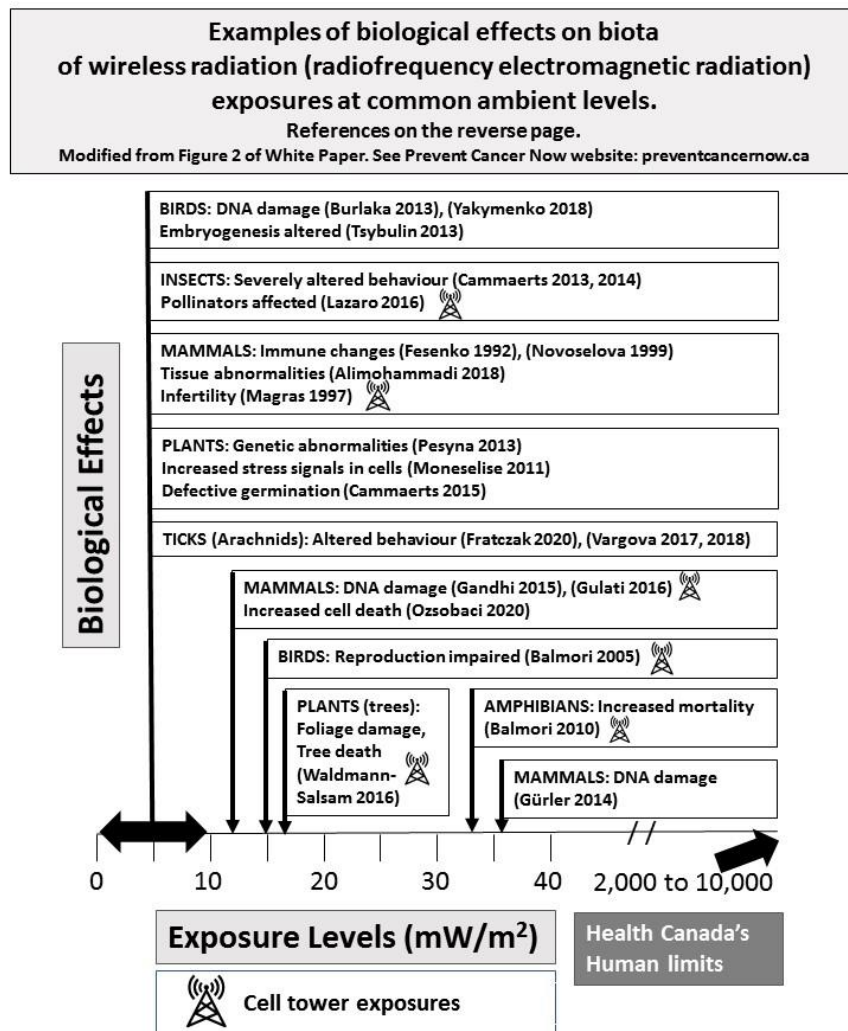


Figure 1. Examples of biological effects on biota of wireless radiation (radiofrequency electromagnetic radiation) exposures at common ambient levels. See the full document: *Protect Birds, Bees and Trees: Include Anthropogenic Radiofrequency Electromagnetic Radiation in Canadian Environmental Protection Act Amendments. White Paper.* (Updated APRIL 2022) by Prevent Cancer Now and Canadians for Safe Technology. https://preventcancernow.ca/wp-content/uploads/2022/05/Include-Anthropogenic-Radiofrequency-Electromagnetic-Radiation-in-Canadian-Environmental-Protection-Act-CEPA-Amendments_PCN-C4ST_2022-04-07.pdf

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Question 5, C4ST’s comments to HC:

The goals seem clear; however, the mechanisms and methods for scientific assessment and regulation are lacking.

A systematic review of the scientific literature in a transparent process, particularly on sperm damage and effects on children is needed with the goal to incorporate protective limits to Safety Code 6 and other NIR-EMF guidelines.

In addition, studies on frequencies used for 5G technologies (6 GHz to 300 GHz) that include non-thermal effects are needed. Health Canada’s threshold limits for 5G technologies¹⁴ are based on only 10 laboratory studies with exposures from a few seconds to no more than 30 minutes duration¹⁵ (Figure 2). These findings are then extrapolated to be safe for 24/7 exposures for all humans. This is of grave concern and merits immediate attention given the case reports from Sweden indicating that 5G technologies can make people ill.¹⁶

¹⁴ Health Canada. (2021). **Notice: Localized human exposure limits for radiofrequency fields in the range of 6 GHz to 300 GHz.** Retrieved from <https://www.canada.ca/en/health-canada/services/health-risks-safety/radiation/types-sources/radiofrequency-fields/notice-localized-human-exposure-limits-range-6-ghz-300-ghz.html>

¹⁵ Gajda, G., Paradis, J., Lemay, E., Zhuk, M., McGarr, G., Bellier, P., & McNamee, J. (2021). **Analysis of recommended localized human exposure limits for radiofrequency fields in the frequency range, 6 GHz to 300 GHz.** *Health Canada, Consumer & Clinical Radiation Protection Bureau (CCRPB). Approved by Narine Martel, Director.* https://preventcancer.ca/Wp-Content/Uploads/2022/02/Analysis-of-Recommendations-above-6-GHz_FINAL-Feb-2-2021.Pdf, 243. Retrieved from https://preventcancer.ca/wp-content/uploads/2022/02/Analysis-of-Recommendations-above-6-GHz_FINAL-Feb-2-2021.pdf

¹⁶ Hardell, L., & Nilsson, M. (2023a). **Case Report: A 52-Year Healthy Woman Developed Severe Microwave Syndrome Shortly After Installation of A 5g Base Station Close to Her Apartment.** *Annals of Clinical and Medical Case Reports*, 10(16), 1–10. Retrieved from <https://acmcase-report.com/pdf/ACMCR-v10-1926.pdf>

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January 2021:
Evidence used to support the Safety Code 6 “complement” that doubled limits for 5G devices:

- The only effects on humans relied on were “over-heating” effects. Studies (10) were 30 minutes or less exposure time.
- All animal studies were short term studies and none were considered to be of “high quality.”
- Findings from tissue and cell studies were excluded from the analysis.

Health Canada Santé Canada

4.0 Assessment of potential adverse health effects from exposure to RFEMF at frequencies from 6 to 300 GHz

Consumer & Clinical Radiation Protection Bureau, Health Canada
775 Brookfield Road, Ottawa, ON, Canada, K1A 1C1

Summary of evidence:
Human Studies:
Of the 10 identified studies on human responses to RFEMF in the 6 to 300 GHz frequency band, most have been conducted by two research groups and have focused on skin temperature changes and the threshold of perceived warmth and heat pain sensation. No human studies were identified that assessed endpoints such as cancer, ocular effects, reproductive system effects, cognitive effects, impacts on the immune system, non-specific symptoms or any other adverse health outcomes in response to exposure to RFEMF in the 6-300 GHz frequency band. The included studies on human outcomes are outlined in Table 4.1.

Page 32.

“No human studies were identified that assessed endpoints such as cancer, ocular effects, reproductive system effects, cognitive effects, impacts on the immune system, non-specific symptoms or any other adverse health outcomes”

Figure 2. Key points from the report Health Canada used to justify making the guidelines laxer for frequencies to be used for 5G technology devices (6 GHz to 300 GHz). This report is not available on the Health Canada website and is available upon request from Health Canada. Also available here: https://preventionnow.ca/wp-content/uploads/2022/02/Analysis-of-Recommendations-above-6-GHz_FINAL-Feb-2-2021.pdf

The principles listed need to be upheld with regard to NIR-EMFs.

- **Vulnerable populations** include humans who have compromised health as a result of disproportionately high exposures to environmental agents (both chemicals and/or NIR-EMFs, as there is considerable overlap in mechanisms and populations experiencing environmental sensitivities in response to both chemicals and/or NIR-EMFs). More on this under C4ST response to Question 14.

The young are also particularly vulnerable, as addressed below under intergenerational equity.

- **Non-regression** is very important as the opposite is happening today, with NIR-EMFs exposures escalating rapidly with the proliferation of wireless transmitters, with higher frequencies and more modulations as technologies are coming onto the market, in built as well as natural environments (including environmentally protected areas).
- **Intergenerational equity:** The young/next generation are disproportionately affected by today’s much higher levels of NIR-EMFs compared with previous generations. There is overwhelming evidence that NIR-EMFs affect sperm, fetal development, as well as development and human health through all life stages.
- **Intergovernmental cooperation** where it exists can be improved, as there is presently often very limited public notice or consultation at the local level regarding plans for a proposed telecommunications (cell) tower, creating last-minute distress and conflicts as tower plans are discovered with not enough notice (if any) for potentially affected residents to investigate details and options. As well, little agency is vested in

local governments to direct and to limit deployment of wireless telecommunications such as cell towers and smaller network antennas.¹⁷

- **National standard:**

National Standards need to be established for NIR-EMF as none currently exist for non-human species even though there is substantial evidence of harm that occurs at everyday levels e.g. from cell tower emissions. The CEPA management cycle must be rigorously adhered to for all pollutants, including NIR-EMF, so there will be effective research, monitoring, enforcement and reporting, so that vulnerable environments are no longer adversely impacted.

Scientific evidence that supports the need for effective National Standards for NIR-EMFs:

Radiofrequencies of 3kHz to 300 KHz: Canadian national standard for non-thermal effects, as a standard does not currently exist. Note: Health Canada's Safety Code 6 limits for human exposures, as the USA Federal Communications Commission (FCC) and the International Commission on Non-ionizing Radiation Protection (ICNIRP), are based on the same erroneous assumption that only heating causes harm.

See this paper: 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.** Environmental Health: A Global Access Science Source, 21(1), 92.

ABSTRACT: In the late-1990s, the FCC and ICNIRP adopted radiofrequency radiation (RFR) exposure limits to protect the public and workers from adverse effects of RFR. These limits were based on results from behavioral studies conducted in the 1980s involving 40-60-minute exposures in 5 monkeys and 8 rats, and then applying arbitrary safety factors to an apparent threshold specific absorption rate (SAR) of 4 W/kg. The limits were also based on two major assumptions: any biological effects were due to excessive tissue heating and no effects would occur below the putative threshold SAR, as well as twelve assumptions that were not specified by either the FCC or ICNIRP. In this paper, we show how the past 25 years of extensive research on RFR demonstrates that the assumptions underlying the FCC's and ICNIRP's exposure limits are invalid and continue to present a public health harm. Adverse effects observed at exposures below the assumed threshold SAR include non-thermal induction of reactive oxygen species, DNA damage, cardiomyopathy, carcinogenicity, sperm damage, and neurological effects, including electromagnetic hypersensitivity. Also, multiple human studies have found statistically significant associations between RFR exposure and increased brain and thyroid cancer risk. Yet, in 2020, and in light of the body of evidence reviewed in this article, the FCC and ICNIRP reaffirmed the same limits that were established in the 1990s. Consequently, these exposure limits, which are based on false suppositions, do not adequately protect workers, children, hypersensitive individuals, and the general population from short-term or long-term RFR exposures. Thus, urgently needed are health protective exposure limits for humans and the environment. These limits must be based on scientific evidence rather than on erroneous assumptions, especially given the increasing worldwide exposures of people and the environment to RFR, including novel forms of radiation from 5G telecommunications for which there are no adequate health effects studies.

<https://doi.org/10.1186/s12940-022-00900-9>

¹⁷ Eight Canadian Non-Government Organizations. (2020, May). URGENT APPEAL to the Government of Canada to Suspend the 5G Rollout and to Choose Safe and Reliable Fibre Connections <https://www.appel5gappeal.ca/>

An example where sound science-based precautionary decision making is lacking with regard to safety for exposure to NIR-EMFs used for newer communications-type technology.¹⁸

Innovation Science and Economic Development Canada (ISED) has adopted Health Canada's guidelines for human exposure to radiofrequency radiation (RFR) as its standard for compliance of commercially available RFR emitting devices and equipment. At ISED's request, Health Canada revised the limits for RFR to be used for 5G technologies (6 GHz to 300 GHz). The revision¹⁹ relaxed the existing limits without any evidence of long term safety.

Health Canada, in its own extensive review of the scientific medical and scientific literature²⁰ determined that *"No human studies were identified that assessed endpoints such as cancer, ocular effects, reproductive system effects, cognitive effects, impacts on the immune system, non-specific symptoms or any other adverse health outcomes in response to exposure to RFEMF in the 6-300 GHz frequency range."* In spite of this lack of evidence of long term safety, Health Canada relaxed the limits as per Safety Code 6²¹ based on 10 studies on heating and pain sensation with duration ranging from a few seconds to no more than 30 minutes and extrapolated those findings to state that the new limits were safe for all exposure times for everyone.

The full report is not available on the government website, but was received by request from Health Canada. The abstract is on the website but it makes no mention that there are no long term studies on safety. Health Canada did not hold a public consultation although this was a recommendation of the 2015 Parliamentary Health Committee (Recommendation 6).

Proper process using the CEPA management cycle should be primary considerations for the right to a healthy environment. Presently, NIR-EMR exposure standards for telecommunications frequencies for humans protect only against over-heating of tissue, as in a microwave oven. Environmental and human health are not protected from myriad injuries and environmental damage from today's wireless deployments, despite extensive, highly concerning research.

The precautionary principle needs to be applied to the issue of NIR-EMFs, based on decades of research confirming adverse environmental and human health injuries.

The following is Table 4.1: Human study characteristics from the "Analysis" report showing the findings upon which long term safety for all individuals in Canada was based. There were 10 studies with a total of less than 100 test subjects, no children, 6 studies were for 3 minutes or less, the longest exposure was for 30 minutes. Exposures were to forearm skin, middle finger skin, skin on back, forehead skin, chest and mid-back. Years the studies were published ranged from 1960 to 2017. Comments in red have been added.

¹⁸ Examples of devices: wearables such as smart watches.

¹⁹ Health Canada. (2021). **Notice: Localized human exposure limits for radiofrequency fields in the range of 6 GHz to 300 GHz.** Retrieved from <https://www.canada.ca/en/health-canada/services/health-risks-safety/radiation/types-sources/radiofrequency-fields/notice-localized-human-exposure-limits-range-6-ghz-300-ghz.html>

²⁰ **"Analysis of Recommended Localized Human Exposure Limits for Radiofrequency Fields in the Frequency Range, 6 GHz to 300 GHz."** Health Canada, Consumer & Clinical Radiation Protection Bureau (CCRPB). Approved by Narine Martel, Director, 2021, 243. https://preventionnow.ca/wp-content/uploads/2022/02/Analysis-of-Recommendations-above-6-GHz_FINAL-Feb-2-2021.pdf

²¹ Health Canada. "Limits of Human Exposure to Radiofrequency Electromagnetic Energy in the Frequency Range from 3 KHz to 300 GHz. Safety Code 6 (2015). http://www.hc-sc.gc.ca/ewh-semt/alt_formats/pdf/consult/2014/safety_code_6_Code_securite_6/Final-Finale-Eng.Pdf

First and last columns added and exposure times in boxes (in red) Modified from Table 4.1: Human study characteristics. P 34 & 35.

In: Health Canada Report. "Analysis of Recommended Localized Human Exposure Limits for Radiofrequency Fields in the Frequency Range, 6 GHz to 300 GHz." Consumer & Clinical Radiation Protection Bureau (CCRPB).

| # | Source | Frequency of RFEMF | Exposure duration and intensity | Tissue exposed | Findings | # test subjects |
|----|-------------------------|------------------------|--|--------------------------------|---|-------------------------------------|
| 1 | Alekseev et al., 2003 | 42.25 GHz | 0.3 to 55 s; 550-2080 W/m ² Exposure, max: 55 seconds | Forearm skin | Measured skin temperatures were similar to those modelled using 2-D PBHE. Increasing beam diameter led to higher peak temperature increase at the same incident power density. Beam diameter had no influence on temperature kinetics for exposures less than 3 s. | 4 Assumed same as 2005 study |
| 2 | Alekseev et al., 2005 | 42.25 GHz | 0 to 20 min; 550-2080 W/m ² Exposure, max: 20 minutes | Forearm and middle finger skin | Increasing blood perfusion was found to decrease maximum tissue temperature increase. Occlusion of blood perfusion resulted in similar temperature responses in tissues with differing basal blood flow. | 4 |
| 3 | Blick et al., 1997 | 7.5, 10, 35 and 94 GHz | 10 s; 0-200 W/m ² Exposure, max: 10 seconds | Skin on back | Skin warmth perception thresholds (195 W/m ² at 7.5 GHz; 45 W/m ² at 94 GHz) were reported in terms of incident power density across a wide frequency spectrum. | 15 |
| 4 | Gustrau and Bohr, 2002 | 77 GHz | 15 min; 10 or 100 W/m ² Exposure, max: 15 minutes | Forearm skin | Measured skin temperatures were similar to those modelled using PBHE (skin with fat layer). Exposure at 10 W/m ² caused less than a 0.1°C temperature increase whereas exposure at 100 W/m ² caused a 0.7°C peak skin temperature increase. | 2 |
| 5 | Hendler and Hardy, 1960 | 10 GHz, 2.5 kHz pulsed | 140 s; 170 W/m ² Exposure, max: 140 seconds | Forehead skin | Threshold of warmth sensation was reported to be a 0.02°C temperature increase at a depth of 150-200 µm below the skin surface. | 7 |
| 6 | Nelson et al., 2003 | 94 GHz, 1 kHz pulsed | 3 s or 3 min; 1750 or 10000 W/m ² Exposure, max: 3 minutes | Forearm skin | Measured skin temperature increases (~7°C) for high power density (10 kW/m ² for 3s) RFEMF exposure were similar to those predicted using PBHE model with no blood flow. Low power density (1750 W/m ²) RFEMF exposure caused an ~8°C temperature increase over 3 min that reached steady state, which was most similar to a moderate blood flow model (17mL/100g/min). The results suggested the PBHE model should adjust for variable blood flow during longer duration exposures. | 4 |
| 7 | Partyla et al., 2017 | 42.25 GHz | 30 min; <172 W/m ² Exposure, max: 30 minutes | Chest | RFEMF exposure had no effect on pain tolerance, time to onset of cold pain or increasing pain threshold under double-blind conditions. | 20 Healthy male adults |
| 8 | Radzievsky et al., 1999 | 42.25 GHz, continuous | 30 min; 250 W/m ² Exposure, max: 30 minutes | Chest | RFEMF exposure caused a ~1.6°C temperature increase in chest skin after 5min, but subjects could not perceive this temperature increase. RFEMF exposure caused a delay in cold pain sensation in the hand and an increase in pain tolerance. No changes were noted in heart rate or blood pressure in response to RFEMF exposure. | 12 Healthy male adults |
| 9 | Walters et al., 2000 | 94 GHz, 1 kHz pulsed | 3 s; 9000 to 17500 W/m ² Exposure, max: 3 seconds | Mid-back | The average power density to evoke a threshold sensation of pain was 12500 W/m ² for a 3 s exposure. This corresponds to a mean increase in surface temperature of 9.9°C from pre-exposure skin temperature (34.0°C) to a threshold temperature of 43.9°C at the end of 3 s. | 10 |
| 10 | Walters et al., 2004 | 94 GHz, 1 kHz pulsed | 4 s or 3 min; 1750 or 10000 W/m ² Exposure, max: 3 minutes | Forearm skin | RFEMF exposure caused a bi-phasic temperature response, with the second phase resulting from local alterations in blood flow. Reduced blood flow resulted in increased peak tissue temperatures. | 6 3 males 3 female |

- **Pollution prevention** is the main solution answer to this type of exposure, as fibre-optic and wired options are higher bandwidth (faster), more resilient and more climate-friendly.²²
- **Polluter pays** is *not* the present case. Human and environmental health is deteriorating, energy and resource use is higher than necessary, and none of these issues are on the ledger of the telecommunications companies. All costs are born by individuals, the healthcare system, and increasingly by the natural environment. NIR-EMFs pose risks to Canada’s biodiversity (see WirelessEnviroImpacts.science²³)

Question 6. Are there other principles within CEPA that could be considered as part of the framework? (Section as above for question 4.)

Question 6, C4ST’s comments to ECCC and HC:

All of the named Principles in the discussion document should be applied to NIR-EMFs. In addition we recommend that the Principle of ALARA (As Low as Reasonably Achievable) and the Substitution Principle be included as guiding principles.

Given the substantial evidence that NIR-EMFs can adversely affect biota, the Precautionary Principle should be applied to minimize emissions and exposures. Safer technologies exist and should be fully explored and implemented without undue delay.

Beneficial principles to add are:

- 1. ALARA, As Low As Reasonably Achievable**, is the guiding principle of radiation safety. ALARA means avoiding exposure to radiation that does not have a direct benefit to you, even if the dose is small.²⁴
- 2. Substitution Principle.** An example of the substitution principle is that hazardous chemicals are replaced by less hazardous alternatives.²⁵ An example application for NIR-EMFs would be the substitution of fast, reliable internet using fibre optic cables and wired connections, instead of wireless connections.

An example for making cell phones safer is provided in this publication: Héroux, P., Belyaev, I., Chamberlin, K., Dasdag, S., De Salles, A. A. A., Rodriguez, C. E. F., ... on behalf of the International Commission on the Biological Effects of Electromagnetic Fields (ICBE-EMF). (2023). **Cell Phone Radiation Exposure Limits and Engineering Solutions.** *International Journal of Environmental Research and Public Health*, 20(7), 5398. <https://doi.org/10.3390/ijerph20075398>

- 3. Responsibility.** In addition, with rights comes responsibly. According to Rights and Responsibilities of Canadian Citizenship includes the responsibility of *“Protecting and enjoying our heritage and environment — Every citizen has a role to play in avoiding waste and pollution while protecting Canada’s natural, cultural and architectural heritage for future generations”*²⁶.

²² URGENT APPEAL to the Government of Canada to Suspend the 5G Rollout and to Choose Safe and Reliable Fibre Connections.: <https://www.appel5gappeal.ca/>

²³ <https://wirelessenviroimpacts.science/>

²⁴ Centers for Disease Control and Prevention (CDC). (2015). **ALARA - As Low As Reasonably Achievable.** Retrieved from <https://www.cdc.gov/nceh/radiation/alara.html>

²⁵ The Substitution Principle. <https://pubmed.ncbi.nlm.nih.gov/21295097/>

²⁶ <https://www.canada.ca/en/immigration-refugees-citizenship/corporate/publications-manuals/discover-canada/read-online/rights-responsibilities-citizenship.html>

Question 7. Are any of these procedural duties unclear?

(Section 3.3 Procedural duties

3.3.1 Access to information

3.3.2 Participation in decision-making

Examples of mechanisms within CEPA and potential opportunities

3.3.3 Access to effective remedies in the event of harm to the environment or human health

Examples of mechanisms within CEPA and potential opportunities)

Question 7, C4ST's comments to ECCC and HC:

Section 22 should be amended so individuals are more able to pursue legal action.

Question 8. Are there other opportunities within the CEPA management cycle to consider these procedural duties and strengthen the protection of the right?

(Section as above for Question 7)

Question 8, C4ST to ECCC and HC:

Data collection and research capacity are required, to track and verify the results of regulation and other actions under CEPA.. Please see response under Question 7.

Question 9. Are there other procedural duties that could be considered as part of the framework?

(Section as above for Question 7.)

Question 9, C4ST's comments to ECCC and to HC:

Overall more information that is easily accessible to the layperson on the levels and sources of NIR-EMFs is needed; e.g. an inventory of installations (*data*), devices including immovable infrastructure and mobile devices (e.g., phones).

Question 10. How can the right to a healthy environment under CEPA support the priorities of First Nations, Inuit, Métis, Modern Treaty Partners, and Self-Governments?

Question 11. How can the framework meaningfully consider Indigenous knowledge systems and bring them together with western knowledge systems to inform science, policy, and program decision-making?

Question 12. Are there specific distinctions-based elements you would like to see incorporated into the implementation framework?

(Section 3.4 Indigenous rights)

Questions 10, 11 AND 12, C4ST's comments to ECCC and HC:

Empower and fund Indigenous research on the topic of biological effects and potential impacts of the environment and human health of NIR-EMFs , particularly if there is substantial use of wireless technologies. We are pleased to see efforts to extend cables to communities, as the safest, as well as the fastest, highest bandwidth, and most reliable and resilient option. These communities should promote the advantages of minimizing wireless radiation.

Question 13. Recognizing that implementation will be progressive and incremental, should the framework prioritize certain activities under CEPA or focus on more general improvement? What would you like to see prioritized?
(Section 4. Proposed approach for the framework)

Question 13 C4ST's comments to ECCC and HC:

Urgently prioritize elevating this topic, so that NIR-EMF pollutants receive at least the same consideration as substances, other pollutants and wastes.

Prioritize minimizing wireless radiation (NIR-EMFs), because it is escalating rapidly as decisions and investments are being made today, as to choices of technologies—hazardous wireless, or superior hard connections (e.g., fibre-optic cable). There is ample evidence that harm is being done to biota, including humans. The present day is the best time to implement the Precautionary Principle, the ALARA principle and the Substitution Principle. In a 2020 report, ECCC recognizes that NIR-EMFs should be considered to be “*a contributing or confounding factor to adverse changes in wildlife, in conjunction with recognized environmental stressors, should be considered.*” (Appendix 3).

The importance of “*recognizing and mitigating effects of artificially generated electromagnetic fields*” was also acknowledged in the Milestone document, an interim report on Canada’s 2030 National Biodiversity Strategy (Appendix 5).

Substantial funding and resource allocation should be dedicated to NIR-EMFs as a pollutant, including a focus on maximizing use of non-radiating technologies. Connectivity, with wires and in particular fibre optic cable (fibre), is the best means to fulfill the need for fast internet. Fibre does not emit radiofrequency (RF) radiation that is harmful; fibre is at least 100 times faster, more reliable, secure and resilient, and is far more protective of privacy than wireless connectivity.²⁷

Question 14. Given that the framework will need to elaborate on research, studies and monitoring to support protection of the right, are there any particular areas of importance related to these activities that should be considered?
(Section as above for Question 13.)

Question 14, C4ST's comments to HC: In Canada, there is a dearth of data on impacts of emissions in the outdoor environment of microwave/radiofrequency radiation such as from telecommunications (cell) tower antennas and smart meters. Airspace as habitat: (aeroecology) should be considered a vulnerable environment to pollutants, including NIR-EMFs.²⁸

Froidevaux, J. S. P., Recuero Virto, L., Czerwiński, M., Thielens, A., & Park, K. J. (2023). **Addressing Wildlife Exposure to Radiofrequency Electromagnetic Fields: Time for Action.** *Environmental Science & Technology Letters*.

ABSTRACT: *With the rapid global expansion of mobile communication networks and the introduction of new radiofrequencies, especially above 6 GHz with the emergence of 5G/6G technology, there is an*

²⁷ Eight Canadian Non-Government Organizations. (2020, May). **URGENT APPEAL to the Government of Canada to Suspend the 5G Rollout and to Choose Safe and Reliable Fibre Connections.** <https://www.appel5gappeal.ca/>

²⁸ Levitt Lai Manville 2021. Effects of non-ionizing electromagnetic fields on flora and fauna, Part 3. Exposure standards, public policy, laws, and future directions <https://pubmed.ncbi.nlm.nih.gov/34563106/>

urgent requirement to investigate and tackle the possible effects of radiofrequency electromagnetic field emissions on wildlife. Here, we highlight (i) the pressing need for robust research on this topic, (ii) the inadequacy of existing guidelines from the International Commission for Non-Ionizing Radiation Protection, which solely address human health, and (iii) the lack of attention given to wildlife exposure to radiofrequency electromagnetic field levels when creating and/or restoring wildlife habitats and deploying new radiofrequency electromagnetic field sources. We call for a common worldwide agenda that would prioritize research on wildlife exposure to radiofrequency electromagnetic fields and for an independent international organization to address this issue. Finally, we provide key recommendations aimed at reducing wildlife exposure to radiofrequency electromagnetic fields while awaiting further evidence. <https://doi.org/10.1021/acs.estlett.3c00795>

Figure 1 illustrates some of the biological effects that low levels of NIR-EMFs can have on biota. Current Health Canada guidelines for humans do not adequately protect non-human species including wildlife, e.g., pollinators. Evidence-based regulation of NIR-EMFs to protect diverse species needs to be prioritized if we are to have a healthy environment. Minimizing wireless pollution to minimize adverse biological effects needs to be made a high priority in the CEPA cycle.

Impacts of small invertebrates, which play a fundamental role in the food supply of other organisms and provide critical services as pollinators, are of particular concern. This field is in urgent need of primary (original) research and monitoring. Some of the topics that need to be studied are provided in these publications:

1. Thielens, A. (2021). **Environmental Impacts of 5G. A literature review of effects of radio-frequency electromagnetic field exposure of non-human vertebrates, invertebrates and plants.** Prepared at the Request of the Panel for the Future of Science and Technology (STOA) and Managed by the Scientific Foresight Unit, within the Directorate-General for Parliamentary Research Services (EPRS) of the Secretariat of the European Parliament, 149. <https://doi.org/10.2861/318352>
2. Thielens, A., Bell, D., Mortimore, D. B., Greco, M. K., Martens, L., & Joseph, W. (2018). **Exposure of Insects to Radio-Frequency Electromagnetic Fields from 2 to 120 GHz.** *Scientific Reports*, 8(1), 3924.

ABSTRACT: *Insects are continually exposed to Radio-Frequency (RF) electromagnetic fields at different frequencies. The range of frequencies used for wireless telecommunication systems will increase in the near future from below 6 GHz (2 G, 3 G, 4 G, and WiFi) to frequencies up to 120 GHz (5 G). This paper is the first to report the absorbed RF electromagnetic power in four different types of insects as a function of frequency from 2 GHz to 120 GHz. A set of insect models was obtained using novel Micro-CT (computer tomography) imaging. These models were used for the first time in finite-difference time-domain electromagnetic simulations. All insects showed a dependence of the absorbed power on the frequency. All insects showed a general increase in absorbed RF power at and above 6 GHz, in comparison to the absorbed RF power below 6 GHz. Our simulations showed that a shift of 10% of the incident power density to frequencies above 6 GHz would lead to an increase in absorbed power between 3–370%. <https://doi.org/10.1038/s41598-018-22271-3>*

3. Thielens, A., Greco, M. K., Verloock, L., Martens, L., & Joseph, W. (2020). **Radio-Frequency Electromagnetic Field Exposure of Western Honey Bees.** *Scientific Reports*, 10(1), 1–14.

ABSTRACT: *Radio-frequency electromagnetic fields (RF-EMFs) can be absorbed in all living organisms, including Western Honey Bees (*Apis Mellifera*). This is an ecologically and economically important global insect species that is continuously exposed to environmental RF-EMFs. This exposure is studied numerically and experimentally in this manuscript. To this aim, numerical simulations using honey bee models, obtained using micro-CT scanning, were implemented to determine RF absorbed power as a function of frequency in the 0.6 to 120 GHz range. Five different models of honey bees were obtained and simulated: two workers, a drone, a larva, and a queen. The simulations were combined with in-*

situ measurements of environmental RF-EMF exposure near beehives in Belgium in order to estimate realistic exposure and absorbed power values for honey bees. Our analysis shows that 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.
<https://doi.org/10.1038/s41598-019-56948-0>

Question 14, C4ST's comments to HC:

Non-ionizing anthropogenic electromagnetic fields (NIR-EMFs) from telecommunications and electrical power supplies are among the most rapidly escalating forms of air pollution. These modulated, pulsed forms of EMF are biologically active, with effects found in every form of life that has been adequately tested (see references to Levitt, et al. C4ST comments under Question 1).

Question 14, C4ST's comments to HC regarding cell tower antenna exposures

Conducting original research projects and monitoring are urgently needed. Although there are numerous studies on adverse effects on people residing in the vicinity of cell towers (base stations/masts) in other countries, no studies have been conducted in Canada. The Precautionary Principle has not been applied e.g., for adequate setbacks of cell towers near schools and homes based on studies by done et al. and others (see below).

Balmori, A. (2022). **Evidence for a health risk by RF on humans living around mobile phone base stations: From radiofrequency sickness to cancer.** *Environmental Research*, 113851.

<https://doi.org/10.1016/j.envres.2022.113851>

Extract: "Overall results of this review show three types of effects by base station antennas on the health of people: radiofrequency sickness (RS), cancer (C) and changes in biochemical parameters (CBP). Considering all the studies reviewed globally (n = 38), 73.6% (28/38) showed effects: 73.9% (17/23) for radiofrequency sickness, 76.9% (10/13) for cancer and 75.0% (6/8) for changes in biochemical parameters. Furthermore, studies that did not meet the strict conditions to be included in this review provided important supplementary evidence."

A partial list of these studies:

1. Abdel-Rassoul, G., El-Fateh, O. A., Salem, M. A., Michael, A., Farahat, F., El-Batanouny, M., & Salem, E. (2007). **Neurobehavioral effects among inhabitants around mobile phone base stations.** *Neurotoxicology*, 28(2), 434–440. <https://doi.org/10.1016/j.neuro.2006.07.012>
2. Blettner, M., Schlehofer, B., Breckenkamp, J., Kowall, B., Schmiedel, S., Reis, U., ... Berg-Beckhoff, G. (2009). **Mobile phone base stations and adverse health effects: phase 1 of a population-based, cross-sectional study in Germany.** *Occupational and Environmental Medicine*, 66(2), 118–123. <https://doi.org/10.1136/oem.2007.037721>
3. Bortkiewicz, A., Zmyslony, M., Szykowska, A., & Gadzicka, E. (2004). **[Subjective symptoms reported by people living in the vicinity of cellular phone base stations: review].** *Med. Pr.*, 55(4), 345–351.
4. Bortkiewicz, Alicja, Gadzicka, E., Szykowska, A., Politański, P., Mamrot, P., Szymczak, W., & Zmyślony, M. (2012). **Subjective complaints of people living near mobile phone base stations in Poland.** *International Journal of Occupational Medicine and Environmental Health*, 25(1), 31–40. <https://doi.org/10.2478/s13382-012-0007-9>
5. Dode, A. C., Leão, M. M. D., Tejo, F. de A. F., Gomes, A. C. R., Dode, D. C., Dode, M. C., ... Caiaffa, W. T. (2011). **Mortality by neoplasia and cellular telephone base stations in the Belo Horizonte municipality, Minas Gerais state, Brazil.** *The Science of the Total Environment*, 409(19), 3649–3665. <https://doi.org/10.1016/j.scitotenv.2011.05.051>

6. Eger, H., Hagen, K. U., Lucas, B., Vogel, P., & Voit, H. (2004). **[The influence of being physically near to a cell phone transmission mast on the incidence of cancer] Einfluss der räumlichen Nähe von Mobilfunksendeanlagen auf die Krebsinzidenz (in German)**. *Umwelt Medizin Gesellschaft -Verlag-Ges.*, 17(4), 1–7. Retrieved from <http://www.baubiologie-brandenburg.de/studien/NailaStudieOrginal.pdf>
7. Eger, H., & Jahn, M. (2010). **Specific Health Symptoms and Cell Phone Radiation in Selbitz (Bavaria, Germany)—Evidence of a Dose-Response Relationship**. *Cell*, (3). Retrieved from https://www.emrpolicy.org/science/research/docs/eger_selbitz_2009.pdf
8. Eskander, E. F., Estefan, S. F., & Abd-Rabou, A. A. (2012). **How does long term exposure to base stations and mobile phones affect human hormone profiles?** *Clinical Biochemistry*, 45(1–2), 157–161. <https://doi.org/10.1016/j.clinbiochem.2011.11.006>
9. Gandhi, G., Naru, J., Kaur, M., & Kaur, G. (2014). **DNA and Chromosomal Damage in Residents Near a Mobile Phone Base Station**. *International Journal of Human Genetics*, 14(3–4), 107–118. <https://doi.org/10.1080/09723757.2014.11886234>
10. Gandhi, Gursatej, Kaur, G., & Nisar, U. (2015). **A cross-sectional case control study on genetic damage in individuals residing in the vicinity of a mobile phone base station**. *Electromagnetic Biology and Medicine*, 34(4), 344–354. <https://doi.org/10.3109/15368378.2014.933349>
11. Gómez-Perretta, C., Navarro, E. A., Segura, J., & Portolés, M. (2013). **Subjective symptoms related to GSM radiation from mobile phone base stations: a cross-sectional study**. *BMJ Open*, 3(12), e003836. <https://doi.org/10.1136/bmjopen-2013-003836>
12. Gulati, S., Kosik, P., Durdik, M., Skorvaga, M., Jakl, L., Markova, E., & Belyaev, I. (2020). **Effects of different mobile phone UMTS signals on DNA, apoptosis and oxidative stress in human lymphocytes**. *Environmental Pollution*, 267, 115632. <https://doi.org/10.1016/j.envpol.2020.115632>
13. Hutter, H.-P., Moshammer, H., Wallner, P., & Kundi, M. (2006). **Subjective symptoms, sleeping problems, and cognitive performance in subjects living near mobile phone base stations**. *Occupational and Environmental Medicine*, 63(5), 307–313. <https://doi.org/10.1136/oem.2005.020784>
14. Levitt, B. B., & Lai, H. (2010). **Biological effects from exposure to electromagnetic radiation emitted by cell tower base stations and other antenna arrays**. *Environmental Reviews*, 18, 369–395. <https://cdnsiencepub.com/doi/full/10.1139/A10-018>
15. López, I., Félix, N., Rivera, M., Alonso, A., & Maestú, C. (2021). **What is the radiation before 5G? A correlation study between measurements in situ and in real time and epidemiological indicators in Vallecas, Madrid**. *Environmental Research*, 194, 110734. <https://doi.org/10.1016/j.envres.2021.110734>
16. Navarro, E., Sequra, J., Portoles, M., & Gomez-Perretta de Mateo, C. (2003). **The Microwave Syndrome: A Preliminary Study in Spain**. *Electromag Biol Med*, 22, 161–169.
17. Oberfeld, G., Enrique, N., Manuel, P., Ceferino, M., & Gomez-Perretta, C. (2004). **The Microwave Syndrome: Further Aspects of a Spanish Study**. 3rd International Workshop on Biological Effects of Electromagnetic Fields, Kos, Greece.
18. Rodrigues, N. C. P., Dode, A. C., de Noronha Andrade, M. K., O'Dwyer, G., Monteiro, D. L. M., Reis, I. N. C., ... Lino, V. T. S. (2021). **The Effect of Continuous Low-Intensity Exposure to Electromagnetic Fields from Radio Base Stations to Cancer Mortality in Brazil**. *International Journal of Environmental Research and Public Health*, 18(3). <https://doi.org/10.3390/ijerph18031229>
19. Santini, R., Santini, P., Danze, J. M., Le Ruz, P., & Seigne, M. (2003). **[Symptoms experienced by people in vicinity of base stations: II/ Incidences of age, duration of exposure, location of subjects in relation to the antennas and other electromagnetic factors]**. *Pathologie-Biologie*, 51(7), 412–415.
20. Santini, R., Santini, P., Le Ruz, P., Danze, J. M., & Seigne, M. (2003). **Survey Study of People Living in the Vicinity of Cellular Phone Base Stations**. *Electromagnetic Biology and Medicine*, 22(1), 41–49. <https://doi.org/10.1081/JBC-120020353>
21. Santini, Roger. (2002). **Study of The Health of People Living in The Vicinity of Mobile Phone Base Stations**. *Pathol Biol*, 50, 369–73. http://www.bibliotecapleyades.net/scalar_tech/esp_scalartech23.htm

22. Singh, K., Nagaraj, A., Yousuf, A., Ganta, S., Pareek, S., & Vishnani, P. (2016). **Effect of electromagnetic radiations from mobile phone base stations on general health and salivary function.** *Journal of International Society of Preventive & Community Dentistry*, 6(1), 54–59. <https://doi.org/10.4103/2231-0762.175413>
23. Sivani, S., & Sudarsanam, D. (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(4), 202–216.
24. Wolf, R., & Wolf, D. (2004). **Increased incidence of cancer near a cell-phone transmitter station.** *International Journal of Cancer*, 1(2). Retrieved from http://www.powerwatch.org.uk/news/20050207_israel.pdf
25. Yakymenko, I., Sidorik, E., Kyrylenko, S., & Chekhun, V. (2011). **Long-term exposure to microwave radiation provokes cancer growth: evidences from radars and mobile communication systems.** *Experimental Oncology*, 33(2), 62–70.
26. Zothansiam, -, Zosangzuali, M., Lalramdinpuui, 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*, 1–11. <https://doi.org/10.1080/15368378.2017.1350584>

Information made available to the public should include readily available searchable databases and mapping applications identifying all telecommunications towers, antennas and associated NIR-EMF emitting equipment with details such as provider and peak power density.

Question 14, C4ST’s comments to HC regarding electromagnetic hypersensitivity (EHS)

Reports from medical doctors specializing in electromagnetic hypersensitivity (EHS) and from non-governmental organizations report increases in numbers of Canadians with clearly a vulnerable population. Only a small minority of Canadian medical practitioners have the knowledge to suspect, conduct a thorough medical history and diagnose human health harms resulting from microwave/radiofrequency radiation.

It appears that little has been done in response to the four recommendations of the 2015 Parliamentary Health committee regrading EHS.²⁹ The symposium held in 2019 was prescient.^{30 31}

Consensus has been reached by medical doctors who specialize in EHS: Physicians’ Health Initiative for Radiation and Environment and British Society for Ecological Medicine et al. (2020, October 11). 2020 Consensus Statement of UK and International Medical and Scientific Experts and Practitioners on Health Effects of Non-Ionising

²⁹ Lobb, B. (2015). Report: Radiofrequency electromagnetic radiation and the health of Canadians Report No. 13 - HESA (41-2) - No. 13 - House of Commons of Canada, 42. <https://www.ourcommons.ca/DocumentViewer/en/41-2/HESA/report-13/>

³⁰ Women’s College Hospital, Toronto. (2019). **Impacts of Wireless Technology on Health: A symposium for Ontario’s medical community - Video of symposium, 31 May 2019:** <https://www.womenscollegehospital.ca/Programs-and-Services/Environmental-Health-Clinic/June-2019-Conference-Videos>.

<https://www.womenscollegehospital.ca/care-programs/environmental-health-clinic/presentation-conference-june2019>

³¹ Bray, R., & Fancy, D. (2021). Proceedings from a Symposium on the Impacts of Wireless Technology on Health. May 31, 2019 Symposium. Environmental Health Clinic, Women’s College Hospital, University of Toronto, Canada, 2021, 134. Retrieved from https://www.womenscollegehospital.ca/wp-content/uploads/2022/06/Symposium_Document_Final_Jan_12.pdf

Radiation (NIR).³²

Of significance is the World Health Organization included unspecified effects of radiation in its 2015 International Statistical Classification of Diseases and Related Health Problems 10th Revision (ICD-10)-2015-WHO Version for 2015: T66 Unspecified effects of radiation.³³

There is a dearth of data on incidence and prevalence of EHS, and no research is urgently needed through funding of entities such as the CANUE (Canadian Urban Environments) or other research groups to examine this escalating environmentally linked serious chronic impairment.

Also of benefit would be to educate medical practitioners with Continuing Medical Education (CME) accreditation development and provision (by independent medical experts) e.g., such as the EMF medical conference held in 2019.³⁴

Information could be collected using the Canadian Health Measures Survey and the Canadian Community Health survey as well as surveying medical professionals with training in this Environmental Medicine topic. We recommend collaboration with expert medical practitioners and citizen/patient groups, some of whom are working with non-governmental organizations such as C4ST, Prevent Cancer Now,³⁵ Environmental Health Association of Manitoba.³⁶ Environmental Health Association of Quebec (L'Association pour la santé environnementale du Québec).³⁷ the Canada-based Electrosensitive Society.³⁸

Pediatricians and other physicians are recommending that individuals limit their use of wireless technologies for a number of reasons, from overt behavioural and learning problems with “digital addiction”, to reproduceable effects on the heart and other organs and body systems, and cancers.³⁹

**Question 15. What information would you need to see to feel confident that the right set out in the framework is being protected in CEPA decision-making? Are there specific actions that should be taken to assess this?
(Section as above for Question 13.)**

Question 15, C4ST’s comments to ECCC and HC:

Biodiversity/populations restored to historic, much higher levels. No species on the Species at Risk Act list.

No environmentally linked illnesses.

The CEPA management cycle will be rigorously adhered to for all potential pollutants, including NIR-EMF. There would be effective data collection, research, monitoring, enforcement and reporting, with transparency, so that all populations, including the most vulnerable, are no longer adversely impacted. There would be an effective enforcement mechanism, a definition of “reasonable limits” that would not undermine the spirit and intention of a “healthy environment” and an effective remedy in the event that alleged violations occur.

³² <https://phiremedical.org/wp-content/uploads/2020/11/2020-Non-Ionising-Radiation-Consensus-Statement.pdf>

³³ <http://apps.who.int/classifications/icd10/browse/2015/en#/T66>

³⁴ EMF – Medical Conference 2021. “Prevention, Diagnosis and Treatment of EMF Associated Illness.” January 2021. <https://emfconference2021.com/>

³⁵ Prevent Cancer Now: <https://preventcancer.ca/>

³⁶ Environmental Health Association of Manitoba: <http://ehamanitoba.weebly.com/>

³⁷ Environmental Health Association of Quebec- L'Association pour la santé environnementale du Québec: <https://aseq-ehaq.ca/en/>

³⁸ Electrosensitive Society: <https://www.electrosensitivesociety.com/>

³⁹ Physicians for Safe Technology: <https://mfsafetech.org/>

Appendix 1. Environmental effects of radiofrequency electromagnetic radiation (RF-EMR) are not addressed in other Canadian Acts nor their regulations.

Copied below and available at:

<https://preventcancer.ca/wp-content/uploads/2022/06/EMRinS5-CEPAScopeBrief-2022-Jn-27.pdf>

Radiofrequency Electromagnetic Radiation investigation belongs in CEPA CEPA is the best-placed Act to investigate environmental hazards and risks of RF-EMR

With rapid deployment of wireless telecommunications, a 2018 report in *The Lancet Planetary Health* stated that the level of radiofrequency electromagnetic radiation (RF-EMR) had increased to about a quintillion (1,000,000,000,000,000,000) times greater than natural background levels, and is harmful.⁴⁰ This radiofrequency radiation can affect all living tissues; Health Canada has issued guidance to prevent over-heating of human tissues.⁴¹ Prevent Cancer Now and Canadians for Safe Technology published a White Paper⁴² summarizing peer-reviewed scientific research on wildlife indicating RF-EMR is likely a co-factor, among many concerns, in the precipitous decline of insects and birds, and stating that RF-EMR should be investigated under the *Canadian Environmental Protection Act* (CEPA).

As Canada has no research, law or policy addressing ecological effects of RF-EMR, Senator Patterson moved amendments to Bill S-5: *Strengthening Environmental Protection for a Healthier Canada Act*, during the Senate Committee for Energy, the Environment and Natural Resources (ENEV) clause-by-clause study. The amendments to Bill S-5 would amend CEPA Section 44 to require study of radiofrequency radiation,⁴³ and amend S. 46 so that the Minister can compel provision of information.⁴⁴

These amendments for science- and data-driven investigation of concerns regarding environmental exposures to RF-EMR and related hazards and risks – never done in Canada – were voted down at committee and third reading. The meeting record indicates that *this decision was not on the merits of the issue*. Although the Senate Law Clerk confirmed that the amendments were in scope for Bill S-5, John Moffet (Assistant Deputy Minister, Environmental Protection Branch, *Environment and Climate Change Canada*) stated that the amendments were out of scope because:

⁴⁰ Bandara, Priyanka, and David O. Carpenter. “Planetary Electromagnetic Pollution: It Is Time to Assess Its Impact.” *The Lancet Planetary Health* 2, no. 12 (December 1, 2018): e512–14. [https://doi.org/10.1016/S2542-5196\(18\)30221-3](https://doi.org/10.1016/S2542-5196(18)30221-3).

⁴¹ Health Canada. “Limits of Human Exposure to Radiofrequency Electromagnetic Energy in the Frequency Range from 3 KHz to 300 GHz. Safety Code 6,” June 22, 2015. http://www.hc-sc.gc.ca/ewh-semt/consult/2014/safety_code_6-code_securite_6/final_finale-eng.php.

⁴² Prevent Cancer Now and Canadians for Safe Technology. “Protect Birds, Bees and Trees. Include Anthropogenic Radiofrequency Electromagnetic Radiation in Canadian Environmental Protection Act Amendments,” April 2022. <https://preventcancer.ca/wp-content/uploads/2022/04/RF-EMRinCEPA-WhitePaper-inclAmendments-PCNC4ST-UPDATED2022April7.pdf>.

⁴³ CEPA S.44 the Ministers shall conduct research or studies relating to radiofrequency, electromagnetic radiation, methods related to its detection, methods to determine its actual or likely short-term or long-term effects on the environment and human health, and preventive, control and abatement measures to deal with it — as well as alternatives to its use — to protect the environment and human health.”

⁴⁴ Expressly include radiofrequency electromagnetic radiation under section 46(1) of CEPA as subparagraph (k.2).

Section 46 occurs under the heading “information gathering” and presently states:

The Minister may, for the purpose of conducting research, creating an inventory of data, formulating objectives and codes of practice, issuing guidelines or assessing or reporting on the state of the environment, publish in the Canada Gazette and in any other manner that the Minister considers appropriate a notice requiring any person described in the notice to provide the Minister with any information that may be in the possession of that person or to which the person may reasonably be expected to have access, including information regarding the following: ...

1. CEPA deals only with “substances” and electromagnetic radiation is not a substance; and Greg Carreau (Director General, Safe Environments Directorate, Health Canada) stated that:
2. Other Acts, specifically the *Radiocommunication Act* and the *Radiation Emitting Devices Act*, address safe applications of RF-EMR.

These statements are inaccurate; RF-EMR could be included in Bill S-5.

[A third “scope” criterion was fulfilled, that amendments pertain to CEPA Sections already in Bill S-5.]

What is the scope of the *Canadian Environmental Protection Act*?

CEPA is “[a]n Act respecting pollution prevention and the protection of the environment and human health in order to contribute to sustainable development.” Pollution is not limited to only “substances,” rather CEPA repeatedly lists and includes, “toxic substances, pollutants and wastes,” so there are distinctions and “pollutants” encompasses more than “substances.” Scientists describe RF-EMR as “pollution.”⁴⁰

Are the amendments “out of scope”?

Pollution Prevention is broadly defined, , including being broad enough to include RF-EMR.

CEPA defines *pollution prevention* as, “the use of processes, practices, materials, products, substances or energy that avoid or minimize the creation of pollutants and waste and reduce the overall risk to the environment or human health.” Alternative technologies not requiring RF-EMR exist for many applications, including for pollution prevention.

Electromagnetic radiation is already within the scope of CEPA. Now it needs to be addressed.

Ultraviolet light (electromagnetic radiation) is harmful, and is addressed under CEPA via regulation of ozone-depleting substances. The substances themselves are not directly toxic; indeed, some of these chemicals were used in inhalers for children.⁴⁵

Do other laws, regulations or guidance address environmental effects of RF-EMR?

Greg Carreau referenced the *Radiation Emitting Devices Act* (Health Canada), and the *Radiocommunication Act* (Industry, Science and Economic Development [ISED]), yet no relevant clauses were found that address environmental effects of RF-EMR in these or other potentially relevant Acts, Regulations or Guidelines (see Summary Table below).

Acts, Regulations and Guidelines examined for assessment and restriction of RF-EMR:

The tabulated documents, including tables of contents and definitions, were examined for relevance to environmental protection from RF-EMR and exposure to RF-EMR, as well as requiring research and the Minister’s ability to compel provision of information.

Environmental protection related documents were searched for terms including: radio, tower, electro, telecom, and Safety Code 6.

Telecommunications/radiofrequency radiation related documents were searched for terms including: human, biota, bird, insect, flora, tree, or plant.

The Summary Table below clarifies that:

1. Environmental effects of RF-EMR are not addressed in these Acts nor their regulations. Neither are concerns regarding RF-EMR addressed in other potentially relevant Acts, Regulations, nor Guidelines referenced in the *Radiation Emitting Devices Act*, the *Radiocommunication Act* or subsequently identified documents.
2. No instrument confers the broad powers for reporting of necessary data, comparable to publication in the Canada Gazette, nor for comprehensive scientific investigation of environmental health related to RF-EMR.

CEPA is the best-placed Act to investigate environmental hazards and risks of RF-EMR

⁴⁵ Ozone-depleting Substances and Halocarbon Alternatives Regulations. 2020. <https://laws-lois.justice.gc.ca/eng/regulations/SOR-2016-137/FullText.html>

Canadian federal acts, regulations and guidance in environmental protection from RF-EMR

| Government of Canada Acts and Regulations | Protection from RF-EMR | | Provisions for Relevant Research and Data Collection |
|--|--------------------------|------------------------------|--|
| | Humans | Non-Human Animals and Plants | |
| Radiation Emitting Devices Act, R.S.C., 1985, c. R-1 Section 4: [emphasis added] “no person shall sell, lease or import into Canada a radiation emitting device if the device (a) does not comply with the standards; (b) creates a risk to any individual of genetic or personal injury, impairment of health or death from radiation by reason of the fact that it (i) does not perform according to the performance characteristics claimed for it, (ii) does not accomplish its claimed purpose, or (iii) emits radiation that is not necessary in order for it to accomplish its claimed purpose.” | NONE | NONE | NONE |
| Radiation Emitting Devices Regulations <u>Do not address cellular antennas and wireless devices.</u> | NONE | NONE | NONE |
| Radiocommunication Act, R.S.C., 1985, c. R-2 Section 4 establishes that in order to install, operate or possess radio apparatus, authorizations (license, certificate) are required and technical standards must be respected. Section 5 gives broad powers to the Minister of ISED to ensure "the orderly development and efficient operation of radiocommunication in Canada." | NONE | NONE | N/A All data pertains to operations. |
| 16 regulations under this Act: None mention RF radiation, nor health nor environmental effects. <i>Radiocommunications Regulations (SOR/96-484)</i> considers adverse effects of EMR on equipment... not on living organisms. – Section 50 (2) | NONE | NONE | NONE |
| Spectrum License Conditions (A2 — Licence Conditions for Spectrum Licences) [*SC6 = Safety Code 6] | Must respect SC6* | NONE | NONE |
| Radio Standard Specifications (RSS-102 – Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands) -- Requirements and measurement techniques to evaluate RF exposure compliance of radiocommunication apparatus to be used within the vicinity of the human body. | Must respect SC6 | NONE | NONE |
| ISED's Tower Siting Policy (Client Procedures Circular CPC-2-0-03, Radiocommunication and Broadcasting Antenna Systems) ** Must comply with environmental legislation, including: CEPA, 1999 ; CEAA, 2012 ; the Migratory Birds Convention Act, 1994 ; and Species at Risk Act . None of these address RF-EMR as a harmful exposure (see below). | Must respect SC6 | NONE** | NONE |
| Canadian Environmental Protection Act, 1999 | NONE | NONE | NOT YET |
| Canadian Environmental Assessment Act, 2012 (now the Impact Assessment Act) | NONE | NONE | RF-EMR not assessed |
| Migratory Birds Convention Act, 1994 and Regulations under this Act | N/A | NONE | RF-EMR not assessed |
| Species at Risk Act | N/A | NONE | RF-EMR not assessed |
| Broadcasting Act (1991) | NONE | NONE | NONE |
| Telecommunications Act and Regulations | NONE | NONE | NONE |

Acts and Regulations

Radiation Emitting Devices Act (R.S.C., 1985, c. R-1): <https://laws-lois.justice.gc.ca/eng/acts/R-1/>

Radiation Emitting Devices Regulations: https://laws-lois.justice.gc.ca/eng/regulations/C.R.C.,_c._1370/index.html

Radiocommunication Act (R.S.C., 1985, c. R-2): <https://laws.justice.gc.ca/eng/acts/r-2/fulltext.html>

Radiocommunication Regulations SOR/96-484: <https://laws.justice.gc.ca/eng/regulations/SOR-96-484/FullText.html>

A2 — Licence Conditions for Spectrum Licences: <https://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf10978.html>

RSS-102 — Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands). Issue 5. March 2015. Spectrum Management and Telecommunications: <https://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf01904.html>

Client Procedures Circular CPC-2-0-03, Radiocommunication and Broadcasting Antenna Systems. Issue 5. Released: June 26, 2014. Effective: July 15, 2014. Spectrum Management and Telecommunications: <https://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf08777.html>

Canadian Environmental Protection Act, 1999 (S.C. 1999, c. 33): <http://laws-lois.justice.gc.ca/eng/acts/c-15.31/FullText.html>

Canadian Environmental Assessment Act, 2012 (Impact Assessment Act): <http://laws-lois.justice.gc.ca/eng/acts/C-15.21/>

Migratory Birds Convention Act 1994 (S.C. 1994, c. 22): <http://laws-lois.justice.gc.ca/eng/acts/M-7.01/FullText.html>

Designation of Regulatory Provisions for Purposes of Enforcement (Migratory Birds Convention Act, 1994) Regulations (SOR/2017-108): <https://laws-lois.justice.gc.ca/eng/regulations/SOR-2017-108/index.html>

Migratory Bird Sanctuary Regulations: https://laws-lois.justice.gc.ca/eng/regulations/C.R.C.,_c._1036/index.html

Migratory Birds Regulations (C.R.C., c. 1035): https://laws-lois.justice.gc.ca/eng/regulations/C.R.C.,_c._1035/index.html

Species at Risk Act (S.C. 2002, c. 29): <http://laws-lois.justice.gc.ca/eng/acts/s-15.3/FullText.html>

Broadcasting Act: <https://laws.justice.gc.ca/eng/acts/B-9.01/>

Telecommunications Act: <https://laws.justice.gc.ca/eng/acts/T-3.4/FullText.html>

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Prepared jointly with volunteers from Canadians for Safe Technology, and Electromagnetic Pollution Illnesses Canada Foundation (EPIC)

Appendix 2. Safer substitutions for technologies are encouraged under CEPA

In the Preamble, 13th paragraph:

“Whereas the Government of Canada recognizes the importance of encouraging the progressive substitution of substances, processes and technologies with alternatives that are safer for the environment or human health, when they are economically and technically viable ...”

There are safer alternatives to wireless technologies, most notably fiber optic and cabled connections.

1. Clegg, F. M., Sears, M., Friesen, M., Scarato, T., Metzinger, R., Russell, C., ... Miller, A. B. (2020). **Building science and radiofrequency radiation: What makes smart and healthy buildings.** *Building and Environment*, 176, 106324. <https://doi.org/10.1016/j.buildenv.2019.106324>
2. Héroux, P., Belyaev, I., Chamberlin, K., Dasdag, S., De Salles, A. A. A., Rodriguez, C. E. F., ... on behalf of the International Commission on the Biological Effects of Electromagnetic Fields (ICBE-EMF). (2023). **Cell Phone Radiation Exposure Limits and Engineering Solutions.** *International Journal of Environmental Research and Public Health*, 20(7), 5398. <https://doi.org/10.3390/ijerph20075398>
3. Schoechle, Timothy. (2018). **Re-Inventing Wires: The Future of Landlines and Networks.** *National Institute for Science, Law & Public Policy Washington, DC*, 156. Retrieved from <http://electromagnetichealth.org/wp-content/uploads/2018/05/Wires.pdf>

Appendix 3. Environment and Climate Change Canada (ECCC) report: *“The potential of increasing EMF exposure as a contributing or confounding factor to adverse changes in wildlife, in conjunction with recognized environmental stressors, should be considered”.*

Canadian Environmental Protection Act (1999): Considerations of electromagnetic fields (radiation) and biota by Kim Fernie, Ph.D., Research Scientist. Environment & Climate Change Canada. 2020

Final paragraph in Dr. Fernie’s report, in **“Overall conclusions and recommendations”**

“Across Canada, increased urban development and an increased reliance on new technologies is likely increasing EMF exposure of wildlife through additional power lines, telecommunications networks, and new technologies (e.g., 4G, 5G). It is conceivable that the RF-EMFs from power lines, telecommunication networks and technologies, may become or already are an environmental stressor to exposed wildlife, in conjunction with other, widely recognized environmental stressors that can affect wildlife, e.g., habitat destruction, climate change, chemical pollutants, heavy metals, among others. The potential of increasing EMF exposure as a contributing or confounding factor to adverse changes in wildlife, in conjunction with recognized environmental stressors, should be considered.”

https://preventcancer.ca/wp-content/uploads/2023/03/Fernie_Report_EMF-Effects-Biota_ENVI-followup_2020.pdf

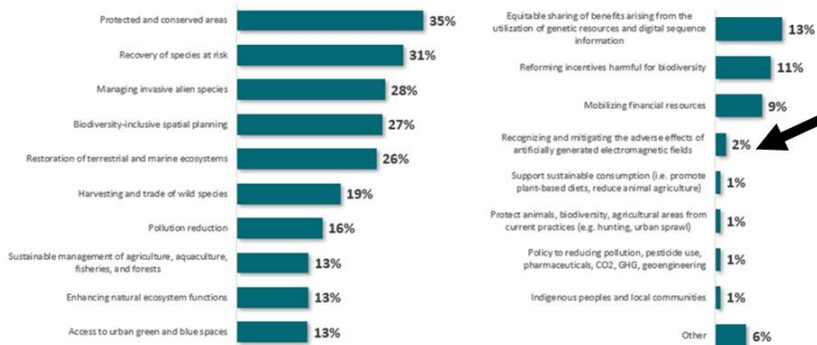
Appendix 4. Canada’s 2030 National Biodiversity Strategy’s Milestone document, Interim report includes electromagnetic fields (EMFs) in Figure 6: “recognizing and mitigating effects of artificially generated electromagnetic fields” and Figure 6b: “reduce pollution”.

RESULTS - ECCC Interim version: Milestone Document, Canada’s 2030 National Biodiversity Strategy. Long description for Figure 6.

Identifying key features for a successful 2030 Biodiversity Strategy

The thematic areas of the Kunming-Montreal Global Biodiversity Framework that received most support for prioritization are “Protected and conserved areas” (35%) and “Recovery of species at risk” (31%).

8. In your opinion, what thematic areas of the Kunming-Montreal Global Biodiversity Framework should Canada prioritize and focus efforts on?



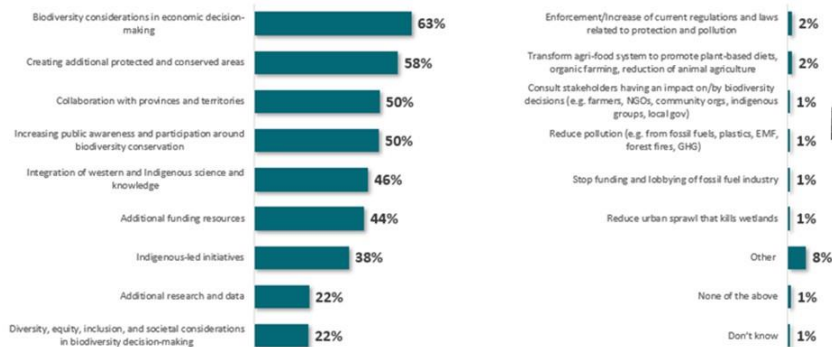
Recognizing and mitigating the adverse effects of artificially generated electromagnetic fields: 2%

Base: All respondents, 2023 (n=2,116)

RESULTS- ECCC Interim version: Milestone Document, Canada’s 2030 National Biodiversity Strategy. Long description for Figure 6b.

Nearly 6 in 10 respondents believe the key features that should be included in Canada’s 2030 Biodiversity strategy are “Biodiversity considerations in economic decision-making” (63%), and “Creating additional protected and conserved areas” (58%).

10. For Canada’s 2030 Biodiversity Strategy to be successful, what do you think are the key features that should be included?



Reduce pollution (e.g. from fossil fuels, plastics, EMF, forest fires, GHG): 1%

Base: All respondents, 2023 (n=2,116)

<https://www.canada.ca/en/environment-climate-change/services/biodiversity/national-biodiversity-strategy/milestone-document.html>

Appendix 5. Non-ionizing anthropogenic electromagnetic fields (NIR-EMFs) and substances can cause adverse effects in combination with substances including synergistic effects

Non-ionizing anthropogenic electromagnetic fields (NIR-EMFs) are a form of energy that can adversely affect matter, including substances. The influence of NIR-EMFs on chemical reactions is well documented in the long-time journal, *Microwave Chemistry*. This journal, well known to chemical engineers, documents the application of low level, non-thermal levels of microwave radiation to accelerate chemical reactions on a commercial scale⁴⁶.

Formation of free radicals is well documented for radiofrequency/microwave (RF/MW) radiation at exposure levels below standards. DNA damage, likely due to oxidative stress and the production of free radicals, has been documented in over 70 studies⁴⁷.

DNA breakage in brain cells under non-thermal conditions, and below Safety Code 6 limits⁴⁸, has also been reported in the \$25 million dollar rat/cell phone radiation study conducted by the National Toxicology Program, National Institute of Environmental Sciences⁴⁹. DNA damage could have multi-generation effects⁵⁰.

Taking all of the factors described above into consideration—demonstrated effects on humans, domestic animals, wildlife and vegetation—the potential far-reaching implications for human life and health are not yet fully studied. It is expected that stressors from exposure to wireless radiation will interact with and be magnified by co-exposures to toxic chemicals and/or other stressors such as temperature fluctuations, heat, water, stress and/or food deprivation.

The following studies with short extracts from the abstracts provide evidence that effects of substances can be altered by exposures to EMFs.

1. Anghileri, L., Mayayo, E., & Domingo, J. (2006). Iron-Radiofrequency Synergism in Lymphomagenesis. *Immunopharmacology and Immunotoxicology*, 28(1), 175–183.

Extract: "...The current results (mortality, clinical and histopathological examinations) demonstrated a synergism between radiofrequency and ferric gluconate..."

2. Anghileri, L., Mayayo, E., & Domingo, J. (2009). Aluminum, calcium ion and radiofrequency synergism in acceleration of lymphomagenesis. *Immunopharmacology and Immunotoxicology*, 31(3), 358–362

Extract: "This study that was done on lymphomagenesis-bearing mice indicates a synergism aluminum-radiofrequency which induces an early increase in mortality that is in concomitance with lymphoid elements proliferation and infiltration of spleen and liver..."

Footnotes:

⁴⁶ See Clegg et al. for references: Clegg, F. M., Sears, M., Friesen, M., Scarato, T., Metzinger, R., Russell, C., ... Miller, A. B. (2020). **Building science and radiofrequency radiation: What makes smart and healthy buildings.** *Building and Environment*, 176, 106324. <https://doi.org/10.1016/j.buildenv.2019.106324>

⁴⁷ Yakymenko, I., Tsybulin, O., Sidorik, E., Henshel, D., Kyrylenko, O., & Kyrylenko, S. (2016). **Oxidative mechanisms of biological activity of low-intensity radiofrequency radiation.** *Electromagnetic Biology and Medicine*, 35(2), 186–202.

⁴⁸ Health Canada, H. C. (2015). **Limits of human exposure to radiofrequency electromagnetic energy in the frequency range from 3 KHz to 300 GHz. Safety Code 6 (2015)**, 24. http://www.hc-sc.gc.ca/ewh-semt/alt_formats/pdf/consult/2014/safety_code_6-code_securite_6/final-finale-eng.pdf

⁴⁹ Wyde, M. (2016). **NTP (National Toxicology Program) toxicology and carcinogenicity studies of cell phone radiofrequency radiation.** Presentation, Bioelectromagnetics Society (BioEM) Meeting, Ghent, Belgium, 32. http://ntp.niehs.nih.gov/ntp/research/areas/cellphone/slides_bioem_wyde.pdf

⁵⁰ Adams, J. A., Galloway, T. S., Mondal, D., Esteves, S. C., & Mathews, F. (2014). **Effect of mobile telephones on sperm quality: a systematic review and meta-analysis.** *Environment International*, 70, 106–112. doi:10.1016/j.envint.2014.04.015

3. Bodera, P., Stankiewicz, W., Antkowiak, B., Paluch, M., Kieliszek, J., Sobiech, J., ... Skopińska-Różewska, E. (2012). Suppressive effect of electromagnetic field on analgesic activity of tramadol in rats. *Polish Journal of Veterinary Sciences*, 15(1), 95–100
 Extract: "The electromagnetic fields (EMFs) have been shown to alter animal and human behavior, such as directional orientation, learning, pain perception (nociception or analgesia) and anxiety-related behaviors. EMF exposure of both frequencies transiently suppressed analgesic effect of tramadol, significantly reducing paw withdrawal latency in animals treated with this drug ..."
4. Byun, Y.-H., Ha, M., Kwon, H.-J., Hong, Y.-C., Leem, J.-H., Sakong, J., ... Kim, N. (2013). Mobile phone use, blood lead levels, and attention deficit hyperactivity symptoms in children: a longitudinal study. *PloS One*, 8(3), e59742
 Extract: "...The results suggest that simultaneous exposure to lead and RF [radio frequency] from mobile phone use was associated with increased ADHD [Attention Deficit Hyperactivity Disorder] symptom risk..."
5. Cervellati, F., Valacchi, G., Lunghi, L., Fabbri, E., Valbonesi, P., Marci, R., ... Vesce, F. (2013). 17-β-estradiol counteracts the effects of high frequency electromagnetic fields on trophoblastic connexins and integrins. *Oxidative Medicine and Cellular Longevity*, 2013, 280850 doi:10.1155/2013/280850
 Extract: "... We demonstrate that 17-β-estradiol modulates Cxs [connexins] and Ints [integrins] as well as ER [estrogen receptor] -β expression induced by HF-EMF [high-frequency electromagnetic fields], suggesting an influence of both stimuli on trophoblast differentiation and migration..."
6. Céspedes, O., Inomoto, O., Kai, S., Nibu, Y., Yamaguchi, T., Sakamoto, N., ... Ueno, S. (2010). Radio frequency magnetic field effects on molecular dynamics and iron uptake in cage proteins. *Bioelectromagnetics*, 31(4), 311–317 doi:10.1002/bem.20564 ".
 Extract: "Superparamagnetic nanoparticles increase their internal energy when exposed to radio frequency magnetic fields due to the lag between magnetization and applied field ... the proteins have a reduced iron intake rate of about 20%. Our results open a new path for the study of non-thermal bioeffects of radio frequency magnetic fields at the molecular scale."
7. Kostoff, R. N., & Lau, C. G. Y. (2013). Combined biological and health effects of electromagnetic fields and other agents in the published literature. *Technological Forecasting & Social Change*, 80(7), 1331–1349
 Extract: "Electromagnetic field (EMF) radiation exerts both stand-alone and combined effects on biological systems. The present study examines the scope of the combined effects; i.e., identify effects on biological systems from combined exposure to electromagnetic fields/radiation and at least one other agent... The number of potential environmental agent combinations is large, and each combination could potentially have beneficial or adverse effects; much work remains to be done before definitive statements about EMF safety can be made."
8. López-Martín, E., Relova-Quinteiro, J. L., Gallego-Gómez, R., Peleteiro-Fernández, M., Jorge-Barreiro, F. J., & Ares-Pena, F. J. (2006). GSM radiation triggers seizures and increases cerebral c-Fos positivity in rats pretreated with subconvulsive doses of picrotoxin. *Neuroscience Letters*, 398(1–2), 139–144.
 Extract: "... We conclude that GSM-type radiation can induce seizures in rats following their facilitation by subconvulsive doses of picrotoxin, and that research should be pursued into the possibility that this kind of radiation may similarly affect brain function in human subjects with epileptic disorders."
9. Maaroufi, K., Save, E., Poucet, B., Sakly, M., Abdelmelek, H., & Had-Aissouni, L. (2011). Oxidative stress and prevention of the adaptive response to chronic iron overload in the brain of young adult rats exposed to a 150 kilohertz electromagnetic field. *Neuroscience*, 186, 39–47
 Extract: "... When EMF was coapplied with IO [iron overload], lipid peroxidation was further increased as compared to EMF alone while the increase in antioxidant defenses triggered by the sole IO was abolished. These data suggest that EMF exposure may be harmful in young adults by impairing the antioxidant defenses directed at preventing iron-induced oxidative stress."