NOTES* REGARDING THIS REPORT:

Canadian Environmental Protection Act (1999): Considerations of electromagnetic fields (radiation) and biota

Kim Fernie, Ph.D.
Research Scientist

Ecotoxicology & Wildlife Health Division
Science & Technology Branch
Environment & Climate Change Canada
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The report is in response to:

1. Recommendation 62 in:
   Government of Canada. (2017). **Healthy Environment, Healthy Canadians, Healthy Economy: Strengthening the Canadian Environmental Protection Act, 1999.** Report of the Standing Committee on Environment and Sustainable Development. Deborah Schulte, Chair. 162 pages.
   https://www.ourcommons.ca/DocumentViewer/en/42-1/ENVI/report-8
2. The commitment of Environment and Climate Change Canada to review the scientific literature provided to the Standing Committee during the public consultation process relating to Electromagnetic Radiation in:
   Government of Canada. (2018). **Follow-Up Report to the House of Commons Standing Committee on Environment and Sustainable Development on the Canadian Environmental Protection Act, 1999.** Submitted by the Minister of Environment and Climate Change and the Minister of Health to the House of Commons Standing Committee on Environment and Sustainable Development on June 29, 2018. Section 3.6.1. 84 pages.
   https://www.canada.ca/en/environment-climate-change/services/canadian-environmental-protection-act-registry/review/standing-committee-report-cepa-2018.html

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.

* These Notes are not prepared by the report's author. The report is appended here, beginning on the next page.

Canadian Environmental Protection Act (1999): Considerations of electromagnetic fields (radiation) and biota

Kim Fernie, Ph.D.
Research Scientist
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1. Background

In December 2016, three stakeholders submitted independent briefs concerning the effects of electromagnetic radiation to humans and wildlife, to the Standing Committee on Environment and Sustainable Development, and requested that electromagnetic radiation be considered in the future under the Canadian Environmental Protection Act (CEPA, 1999). The three stakeholders were Margaret Friesen (former biologist with the Government of Canada), Dr. Magda Havas (Professor, Trent School of the Environment, Trent University, ON, Canada), and a single submission from the three groups Prevent Cancer Now, Chemical Sensitivities Manitoba, and National Network on Environments and Women's Health. In 2017, these submissions were considered under CEPA (1999) in the review by the Standing Committee on Environment and Sustainable Development. In their subsequent report (Schulte 2017), the Standing Committee "recommended that Health Canada and Environment and Climate Change Canada conduct studies on the effects of electromagnetic radiation on biota, review the adequacy of the current guidelines provided in Safety Code 6 and report their findings back to the Committee" (**Recommendation 62**; see Schulte 2017, pp. 79 – 80). In the Follow-Up Report (Unknown 2018, pp. 23), Health Canada determined that there was no danger to the public from exposure to radiofrequency electromagnetic energy below levels specified in Safety Code 6 in 2018 (i.e., frequency range 3 kHz to 300 GHz; https://www.canada.ca/en/health-canada/services/environmental-workplace-health/reports-publications/radiation/safety-code-6-health-canada-radiofrequency-exposure-guidelines-environmental-workplace-health-health-canada.html), while Environment & Climate Change Canada (ECCC) committed to reviewing the scientific evidence provided to the Committee on the effects of radiofrequency electromagnetic fields (RF-EMFs) on biota. The following report reflects this commitment by ECCC to provide a holistic review (not an exhaustive review) of the scientific evidence of the effects of RF-EMFs on wildlife, provided by the stakeholders to the Standing Committee in December 2016.

2. Terminology for the Current Report.

For the purposes of this report here, "biota" are considered to be "migratory birds, endangered species or other wildlife" as stated in the Canadian Environmental Protection Act (1999; p29). In addition, the term "radio-frequency electromagnetic fields" or RF-EMFs or EMFs, is used as it is in the peer-reviewed scientific literature to cover the various terms used by the three

stakeholders in their submissions to the Standing Committee in December 2016 (e.g., "electrosmog", "radiation", among other terms). Other terms and corresponding acronyms used in this report and the scientific peer-reviewed literature, include the following: **DECT**: digital enhanced cordless telecommunications; **EMFs**: electromagnetic fields; **GSM**: global system for mobile communications; and **RF-EMFs**: radiofrequency electromagnetic fields; **RFR**: radiofrequency radiation.

3. Summaries of Stakeholder Submissions in December 2016.

a) Dr. Magda Havas states that her submission is from herself and not from her employer, Trent University, or the Trent School of the Environment where she is a professor. In her submission, Dr. Havas concluded that the various forms of electromagnetic frequencies from low frequency EMFs, radio frequency radiation, and microwave radiation, adversely affect plants and animals. She stated that adverse biological effects occur below existing federal (Safety Code 6) and provincial guidelines, while there is an exponential increase in exposure to "electrosmog (non-ionizing electromagnetic pollution)". Dr. Havas defined "electrosmog" as pollution from extremely low frequency EMFs (less than 300 Hz), intermediate frequencies (kHz range), and radio frequencies (up to 300 GHz), including microwave radiation (300 MHz to 300 GHz). She further stated that the primary focus of the federal government under CEPA (1999) has been on chemical pollutants and not on EMFs in the environment, with, in her opinion, no apparent leadership to lower associated EMF guidelines and reduce such exposure to levels that "do not endanger biota or public health." Dr. Havas recommended that "CEPA examine the research related to harmful effects of EMFs on biota" and provide recommendations to agencies responsible for protecting biota. Dr. Havas then provided an overview of the various effects of RF-EMFs including changes in behaviour, reproduction, and for some species, population declines, in bees, birds, amphibians, plants, and dairy cows, purportedly presented in scientific publications.

b) A second brief was submitted to the Standing Committee on Environment and Sustainable Development, by Margaret Friesen, now a retired biologist from the Government of Canada. In her brief, Ms. Friesen indicated that she had presented a poster at a provincial entomology meeting in Manitoba, reviewing the literature on biological effects of wireless radiation on insects and calling for studies on honey bees. She was concerned about the possible effects of RF-EMFs on bee colonies in relation to colony collapse, stating that RF-EMFs "could be a factor in weakening the bees' ability to withstand other insults [pesticides, viruses]." Ms. Friesen indicated that she had found a number of studies demonstrating adverse effects of EMFs at below current safety guidelines for humans, and included an appendix of 91 references, some of which showed no RF-EMF effects and other studies reporting effects that she stated "could have substantial impacts on survival and reproduction which … would affect ecosystems." Ms. Friesen stated that the purpose of her

brief was to provide some evidence in support of the concept that RF-EMFs should be considered an environmental pollutant and added to a revised CEPA (1999).

c) The submission by Prevent Cancer Now, Chemical Sensitivities Manitoba, and the National Network on Environments and Women's Health (PCN, CSM, NNEWH 2016), stated that "radiofrequency radiation (RFR) as used in wireless communications has biological effects at exposure levels well below those permitted under Health Canada's Safety Code 6, and can act synergistically with chemical toxicants. As such, rapidly escalating exposures to RFR should be considered for incorporation in assessments of chemical toxicity." Their evidence supporting this statement involved studies examining effects of cell phone radiation (study species: mice) or usage (students), at times in combination with exposure to aluminum or iron (mice), or blood lead concentrations (students). This third submission recommended recognition that "electromagnetic radiation has biological effects at low exposure levels, and interacts with biological systems to enhance toxicity of chemicals." In scientific research, laboratory mice are used as models for human toxicology and medical research, but are not appropriate models for wildlife species, since mice, and not wildlife, can be genetically selected for predisposition to developing tumours, cancers, diseases and other medical conditions found in humans but not wildlife. To the best of my knowledge as a federal wildlife toxicologist and research scientist, the occurrence of cancers in wildlife has not been reported in the peer-reviewed scientific literature, possibly because many wildlife species are very short-lived. Since the 2016 submission of PCN, CSM, NNEWH focused on possible RF-EMF effects to species (e.g., mice, humans) not representative of wildlife, a summary of the literature provided in the submission is not provided in this report.

4. A Summary of Selected Peer-reviewed Scientific Literature Provided in Submissions.

This section summarizes the major findings and conclusions of scientific publications randomly selected from those submitted by Professor Havas and Ms. Friesen. The submission by Ms. Friesen included 91 references from the peer-reviewed scientific literature and the non-peer-reviewed "grey" literature; some of these references reported apparent effects of RF-EMFs on taxa of interest, while other publications reported no effects of EMFs, or extended beyond the focus of this report (i.e., possible effects of RF-EMFs on wildlife). For example, a considerable number of the references characterized the use of electric and magnetic fields, including the earth's geomagnetic field, by birds and insects when foraging and migrating (e.g., Kirschvink et al. 1997). Here (Section 4.0), this summary is presented according to possible effects of RF-EMFs on wildlife taxa (i.e., insects, amphibians, birds). It should be noted that for the majority of the publications cited here, only the abstracts were available for review and summary, and not the full publication describing the materials and methods employed in the studies; this limited access was because of the costs associated with purchasing the full publications that were otherwise not available through the federal government portal and journal subscriptions. Publications provided by Professor Havas and Ms. Friesen were excluded when they reported

on studies involving non-wildlife species, i.e., dairy cows and plants, since they exceed the scope of this report. In addition, non-peer-reviewed literature (e.g., conference abstracts) and publications not published in English (the official language of Science) were excluded, thereby excluding some recommended references by Ms. Friesen (e.g., Kimmel et al. 2007). The peer-reviewed literature was accessed through Google Scholar and not the EMF Portal provided by Ms. Friesen, since federal IT Security identified the EMF Portal as a "Security Risk. Attackers might be trying to steal your information from www.emf-portal.org (for example, passwords, messages, or credit cards). NET::ERR_CERT_AUTHORITY_INVALID."

Bees. A variety of hypotheses exist to potentially explain the collapse of honey bee colonies, including exposure to pesticides, new and emerging diseases, and parasites, with some authors suggesting exposure to EMFs as a possible explanation. In an early study, Westerdahl and Gary (1981) exposed adult honey bees (unspecified Latin name) to 2.45 GHz continuous wave microwave radiation at varying power densities for 0.5, 6 and 24 hours, and found that there were no significant differences in sucrose syrup consumption or mortality of the bees. Gary and Westerdahl (1981) concluded that microwaves associated with ground-based microwave receiving stations, would not affect airborne invertebrates like honey bees (Latin name not specified) during transient passage, since honey bees retained normal flight, orientation, and memory function after exposure for 30 minutes to 2.5 GHz CW microwaves at power densities from 3 – 50 mW/cm^2. Favre (2011) reported that mobile phone handsets induced the piping signal of worker bees, a signal of a disturbed or swarming bee colony. Sample sizes in the Favre (2011) study were small, involving two mobile phones and five bee hives, suggesting caution be used in interpreting these results. Caution is strongly recommended in interpreting the reported results of Kumar et al. (2011) because of the experimental design, methodologies and lack of statistical methods provided in the publication. Kumar et al. (2011) reported that worker honey bees (*Apis mellifera* L.) experienced biochemical changes, initially were less active (i.e., reduction motor activity) but then moved in mass migration toward the cell phone used in the study. In another publication (Sharma and Kumar 2020) that failed to provide any statistical methodology, the placement of two functional cell phones (GSM 900 MHz frequency) on the side walls of two honey bee (*A. mellifera* L.) colonies, reportedly resulted in a reduced brood area, fewer eggs/day produced by the queen, a decline in foraging and activity, and eventually an absence of honey, pollen, brood and bees in the colony. It does not appear that Harst et al. (2006) is a peer-reviewed publication, and further caution should be used in interpreting the results (i.e., reduced beehive weight exposure to radiation of DECT-phones) because of the very small sample size and lack of statistical methods.

Ants. Exposure of six colonies of ants (*Myrmica sabuleti*) to GSM 900 MHz radiation was reported to adversely affect their olfactory and/or visual memory when searching for food, with the ants failing to show an association between food and olfactory or visual cues under such conditions (Cammaerts et al. 2012). In another study (Cammaerts et al. 2013), also with *M. sabuleti* ants, exposure to electromagnetic waves (unspecified) adversely affected the ants

foraging behaviour, shortening distances travelled on food collection trails, failing to arrive at marked areas or orienting themselves to a source of alarm pheromone, becoming unable to return to their nest to recruit other ants for food collection, and resulting in deterioration of their colonies after 180 hours.

Amphibians. In a study by Balmori (2010), eggs and tadpoles of the common frog (*Rana temporaria*) were exposed to electromagnetic radiation from several mobile phone antennae (electric field: 1.8 – 3.5 V/m) for two months, and were reported to lack coordination, demonstrated asynchronous growth, and high mortality (90%) compared to controls. In contrast, the control frogs, concurrently raised in the same pond but in a Faraday cage used to block EMFs, showed normal coordination of movements, synchronous development, and a mortality rate of 4.3% (Balmori 2010). In an earlier review paper, Balmori (2006) assessed the possible effects of radiofrequency radiation from wireless telecommunications on amphibians, stating that "electromagnetic pollution" (in the microwave and radiofrequency range) is a possible cause of deformations and decline of some amphibian populations, and called for additional studies to determine the possible effects on amphibians.

Bats. In a unique study investigating the possible use of electromagnetic fields to deter bats from colliding with wind turbines, a major source of mortality for bats, Nicolls and Racey (2007) discovered that there was a significant reduction in bat activity in habitats exposed to an RF-EMF strength of greater than 2 v/m compared to sites without registered RF-EMF levels. There was also a modest but statistically insignificant reduction in activity of the bats at lower RF-EMF levels within 400 m of the radar.

Birds. Considerably more research has been conducted to assess possible RF-EMF effects on birds compared to other wildlife species. Much research has focused on how birds use the earth's geomagnetic fields to orient themselves appropriately during migration, and some of these studies address that in conjunction with exposure to RF-EMFs.

In terms of declining bird populations, Balmori and Hallberg (2007) hypothesized that electromagnetic radiation (microwaves) from phone antennae may be a contributing factor, either in isolation or in combination with other factors, to the decline of house sparrows (*Passer domesticus*) in Spain, and by extension, possibly in the UK and western Europe. During their 3.5 year study, Balmori and Hallberg (2007) identified that there was a significant decline in the density of house sparrows at their study site that was statistically associated with the electric field strength from the phone antennae. In another study on house sparrows in Belgium, Everaert and Bauwens (2007) reported that the number of male sparrows was negatively associated with electric field strength of the 900 and 1800 MHz frequency bands from GSM base stations in their six study areas, regardless of inter-site differences in the number of birds and radiation levels. Everaert and Bauwens (2007) concluded that their

findings supported “the notion that long-term exposure to higher levels of radiation negatively affects the abundance or behaviour of house sparrows in the wild.”

In terms of reproduction, total productivity but not partial productivity of white storks (*Ciconia ciconia*) was adversely affected when nesting within 200 m of the antenna of a cellular phone base station (electric field: 2.36 ± 0.82 V/m) compared to storks nesting more than 300 m from the antennae (EF: 0.53 ± 0.82 V/m) in Valladolid, Spain (Balmori 2004). In a controlled captive study, American kestrels (*Falco sparverius*) exposed to EMFs of a 735 kV transmission line, laid larger eggs with thinner eggshells, had better fertility and fledging success (1 year only), but had poorer hatching success with fewer fertile eggs hatching per kestrel pair (2 years) (Fernie et al. 2000a). Tanner and Romero-Sierra (1982) reported that one colony of white leghorn chickens, a domesticated species, produced more eggs (13.7%) but experienced double the mortality rate when exposed to a 7.06 GHz CW microwave transmitter, compared to controls. Ubeda and colleagues (1994) reported that only one of two groups of chicken embryos exposed for two days to pulsed magnetic fields (100 Hz repetition rate, 1.0 µT peak-to-peak amplitude, 500 µs duration), had a higher rate of early embryonic death and a greater percentage of developmental anomalies compared to sham-exposed chicken embryos. It was not possible to locate the Grigoriev (2003) or Ingol and Ghosh (2006) publications on Google Scholar that were provided in the submission of Dr. Havas.

Avian Migration. In the review paper by Loss et al. (2014), the authors concluded that there was little information available to quantify the vulnerability of specific species to mortality from power lines, with over-representation of some bird groups and habitats, and most studies focusing on one or a few avian species. Loss and colleagues (2014) identified that additional research was needed to “clarify whether, to what degree, and in what regions populations of different bird species are affected by power line-related mortality”, yet concluded that reducing the substantial bird mortality at U.S. power lines, estimated to be 12 – 64 million birds annually, required conservation management and policy. Engels et al. (2014) reported that electromagnetic noise in the frequency range of 50 kHz to 5 MHz, prevented migrating European robins (*Erithacus rubecula*) from orienting themselves through using their magnetic compass, an important element in avian migration. Yet, Wiltschko et al. (2015) concluded that there were no lasting adverse effects to the temporary inability of birds to adjust to radio-frequency fields that disabled the avian compass under such conditions, and found that immediately after such exposure, birds were able to orient to the local geomagnetic field that they use during migration.

5. Additional Publications to be considered

The following section describes the findings and conclusions of other peer-reviewed, scientific publications regarding possible RF-EMF effects on wildlife. Each of the peer-reviewed scientific publications cited in Section 5.0 (here), provide many additional references that could be consulted for further information about possible RF-EMF effects on wildlife. Once again, these

references in Section 5.0 were randomly selected and do not represent an exhaustive review of the related scientific literature on RF-EMFs and wildlife. They should be considered as supplemental to those provided in the submissions of Professor Havas and Ms. Friesen.

For the purposes of transparency, the author of this report, Dr. Kim Fernie, conducted research for her doctoral dissertation (McGill University, 2008) investigating possible effects of EMFs from power lines on birds, notably EMFs generated by the largest transmission line (735 kV) in Canada. Her laboratory research with a wild bird species was conducted at McGill University with the guidance and support of Hydro Quebec, that at the time was conducting controlled laboratory studies determining potential effects of EMFs on dairy cattle. As well as identifying reproductive changes in American kestrels (previously discussed in Section 4.0, *birds*), Fernie's research identified morphological, developmental, physiological and endocrine effects in captive American kestrels exposed for up to 70 days of their annual breeding season to a 60 Hz electrical current that generated a magnetic field of 30 μT and an electric field of 10 kV/m. There were no significant changes in the mortality of the kestrel adults or nestlings, but a significant increase in embryo mortality (assessed as the percentage of fertile eggs that hatched per breeding pair of kestrels), over the two years of Fernie's research. Adult male kestrels were heavier when feather molting began, started to molt earlier (Fernie and Bird 1999), and experienced physiological (Fernie and Bird 2001) and endocrine (Fernie et al. 1999) changes when exposed to EMFs compared to control males. Both adult male and female kestrels were more active and experienced other behavioral changes under EMF conditions (Fernie et al. 2000b). Raised by these same adult birds, kestrel chicks (both sexes) were heavier and had longer bones despite delays in maximal growth for the male chicks, when exposed to EMFs (Fernie and Bird 2000).

In their review paper, Fernie and Reynolds (2005) evaluated previously reported effects of EMFs from power lines on avian reproductive biology and physiology. Fernie and Reynolds (2005) determined that most studies reported that EMF exposure generally adversely altered avian behaviour, reproductive success, growth and development, physiology and endocrinology, but changes were not necessarily consistent in effect or in direction. The reported EMF effects were observed in multiple bird species, including passerines, birds of prey, and chickens, in laboratory and field studies. The authors concluded that much of the uncertainty in reported findings concerning EMF effects on birds, was a result of the limited number of EMF studies with birds.

Cucurachi et al. (2012) presented a systematic review of 113 published scientific studies on potential effects of RF-EMFs in the range of 10 MHz to 3.6 GHz (from amplitude modulation to lower band microwave EMF). Similar to Fernie and Reynolds (2005), Cucurachi et al. (2012) found that there were a limited number of ecological field studies, with most being laboratory studies determining possible effects of EMFs on birds and other taxa (e.g., plants, invertebrate organisms, laboratory mice and rats). They identified that very few scientific studies (N = 6) had

been conducted with honey bees to determine possible effects of EMFs. Similar to the concerns identified above (Section 4.0 *bees*), Cucurachi et al. (2012) documented scientific concerns about the few studies with honey bees, specifically that the publications reporting EMF effects on honey bees provided limited statistical information about the scale of the reported effects, and did not account for other confounding parameters (e.g., placement of the emitting device inside the hives). Cucurachi et al. (2012) identified that overall, nearly two-thirds (65%) of the reviewed studies reported ecological effects of RF-EMF at high and low dosages, and this included 50% of animal studies and 75% of plant studies. Cucurachi et al. (2012) could not discern a clear EMF dose-effect relationship across the 113 studies, but identified that effects were found in studies with longer exposures, were more likely to occur with GSM frequency ranges, and were observed at very low EMF dosages compatible with real field situations under environmental conditions. Notably, the authors concluded that there is limited possibility to generalize EMF results from an organism to an ecosystem level because of the lack of standardized observations and limited number of studies to date (Cucurachi et al. 2012).

6. Overall conclusions and recommendations.

At this time (November 2020), there remains an insufficient number of EMF-wildlife-ecological studies to identify if there are consistent effects of RF-EMFs among species, habitats, and ecosystems. This conclusion reflects the findings of two scientific review papers (Fernie and Reynolds 2005; Cucurachi et al. 2012) that concluded there are generally effects of EMFs on birds and other wildlife biota, but the direction and intensity of these effects are not necessarily the same among species or studies. Some scientific publications have reported adverse effects or no effects of RF-EMFs on wildlife in laboratory and field studies. Furthermore, Fernie and Reynolds (2005) and Cucurachi et al. (2012) concluded that additional research was required to clarify and identify if there are consistent effects of RF-EMFs on wildlife. Cucurachi et al. (2012) stated that there is a definitive need for the study of RF-EMF effects on more wildlife species, populations and ecosystems, through appropriate field and laboratory studies, to generate recommendations and inform ecologically-relevant policy.

Current wildlife toxicology seeks to identify potential effects of chemical pollutants *before* reaching adverse population level effects (e.g., mortality, population declines) to inform the development of appropriate strategies concerning environmental pollutants (e.g., chemicals, pharmaceuticals, personal care products) in order to protect the Canadian environment under CEPA (1999). Similar to multiple environmental chemical pollutants, there is scientific evidence of EMFs having similar endocrine, physiological and reproductive effects on some wildlife, although not consistent effects among species or across studies. Furthermore, there appears to be minimal evidence of increased mortality to wildlife from EMF exposure reported in the reviewed scientific publications.

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.

7. Literature Cited.

Balmori A, Hallberg O. 2007. The urban decline of the house sparrow (*Passer domesticus*): a possible link with electromagnetic radiation. Electromagnetic Biology & Medicine 26: 141-151.

Balmori A. 2004. Possible Effects of Electromagnetic Fields from Phone Masts on a Population of White Stork (*Ciconia ciconia*). Electromagnetic Biology & Medicine 24: 109–119.

Balmori A. 2006. The incidence of electromagnetic pollution on the amphibian decline: Is this an important piece of the puzzle? Toxicological & Environmental Chemistry 88: 287–299.

Balmori A. 2010. Mobile phone mast effects on common frog (*Rana temporaria*) tadpoles: the city turned into a laboratory. Electromagnetic Biology and Medicine, 29: 31–35

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: 151–165.

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: 315–332.

Canadian Environment Protection Act (CEPA, 1999 (Consolidation). S.C. 1999, c. 33. Current to 5 October 2020. Published by the Minister of Justice at the following address: http://laws-lois.justice.gc.ca

Cucurachi S, Tamis WL, Vijver MG, Peijnenburg WJ, Bolte JF, de Snoo GR. 2013. A review of the ecological effects of radiofrequency electromagnetic fields (RF-EMF). Environment International : 51, 116–140.

Engels S, Schneider N-L., Lefeldt N, Hein CM, Zapka M, Michalik A, et al. 2014. Anthropogenic electromagnetic noise disrupts magnetic compass orientation in a migratory bird. Nature 509: 353–356.

Everaert J, Bauwens D. 2007. A possible effect of electromagnetic radiation from mobile phone base stations on the number of breeding house sparrows (*Passer domesticus*). Electromagnetic Biology & Medicine 26: 63–72.

Favre D. 2011. Mobile phone-induced honeybee worker piping. Apidologie 42: 270-279.

Fernie KJ, Reynolds SJ. 2005. The effects of electromagnetic fields from power lines on avian reproductive biology and physiology: a review. Journal Toxicology & Environmental Health B. Critical Reviews. 8: 127-140.

Fernie KJ, Bird DM, Dawson RD, Laguë, PC. 2000a. Effects of electromagnetic fields on reproductive success of American kestrels. Physiol. Biochem. Zool. 73: 60-65.

Fernie KJ, Leonard NJ, Bird DM. 2000b. Behavior of free-ranging and captive American kestrels under electromagnetic fields. Journal Toxicology & Environmental Health. 59A: 101-107.
Fernie KJ, Bird DM. 2000. Growth of nestling American kestrels when exposed to electromagnetic fields. Condor 102: 462-466.
Fernie KJ, Bird DM, Petitclerc, D. 1999. Effects of electromagnetic fields on photophasic circulating melatonin levels of American kestrels. Environmental Health Perspectives 107: 901-904.
Fernie KJ, Bird DM. 1999. Effects of electromagnetic fields on body mass and food-intake of American kestrels. Condor 101:616-621.
Fernie KJ. 1998. Effects of electric and magnetic fields on selected physiological and reproductive parameters of American kestrels. Doctoral Dissertation. McGill University. 110 pp.
Gary NE, Westerdahl BB. 1981. Flight, orientation, and homing abilities of honeybees following exposure to 2.45-GHz CW microwaves. Bioelectromagnetics, 2: 71–75.
Grigoriev Y. 2003. Biological effects of mobile phone electromagnetic field on chick embryo (risk assessment using the mortality rate). Radiats Biol Radioecol. 43: 541-543.
Harst W, Kuhn J, Stever H. 2006. Can electromagnetic exposure cause a change in behaviour? Studying possible non-thermal influences on honeybees. An approach within the framework of educational informatics. Acta Systematica – IIAS Intern. J. 6: 1–6.
Ingol IV, Ghosh SK. 2006. Biomedical Research 17: 205-210. (Not found in Google Scholar which identified this reference as being provided by Magda Havas in her CEPA briefing).
Kimmel S, Kuhn J, Harst W, Stever H. 2007. Electromagnetic radiation: influences on honeybees (*Apis mellifera*). In Preprint (IIAS-InterSymp Conference, Baden-Baden 2007) http://agbi.uni-landau.
Kirschvink J, Padmanabha S, Boyce C, Oglesby J. 1997. Measurement of the threshold sensitivity of honeybees to weak, extremely low-frequency magnetic fields. Journal of Experimental Biology, 200: 1363–1368.
Kumar NR, Sangwan S, Badotra P. 2011. Exposure to cell phone radiations produces biochemical changes in worker honey bees. Toxicology International, 18: 70–72.
Loss SR, Will T, Marra PP. 2014. Refining Estimates of Bird Collision and Electrocution Mortality at Power Lines in the United States. PLoS One. 9: e101565. https://doi.org/10.1371/journal.pone.0101565
Nicholls B, Racey PA. 2007. Bats Avoid Radar Installations: Could Electromagnetic Fields Deter Bats from Colliding with Wind Turbines? PLoS One. 2:e297. https://doi.org/10.1371/journal.pone.0000297
Pattazhy S. 2009. The Times of India, 31 August 2009. http://timesofindia.indiatimes.com/NEWS/Science/Mobile-phone-towers-a-threat-to-honeybees-Study/articleshow/4955867.cms
Sharma VP, Kumar NR. 2010. Changes in honeybee behaviour and biology under the influence of cellphone radiations. Current Science (Bangalore). 98: 1376–1378.
Shulte D. 2017. Canadian Environmental Protection Act (1999): Eighth Report of the Standing Committee on Environment and Sustainable Development, 42nd Parliament, 1st Session. 162 pp.

Svenja E, Schneider N-L, Lefeldt N, Hein C, Zapka M, Michalik A, Elbers D, Kittel A, Hore PJ, Mouritsen, H. 2014. Anthropogenic electromagnetic noise disrupts magnetic compass orientation in a migratory bird. Nature. 509: 353-356.

Tanner JA, Romero-Sierra C. 1982. The Effects of Chronic Exposure to Very Low Intensity Microwave Radiation on Domestic Fowl. Journal of Bioelectricity 1: 195–205.

Ubeda A, Trillo MA, Chacon L, Blanco MJ, Leal J. 1994. Chick embryo development can be irreversibly altered by early exposure to weak extremely low frequency magnetic fields. Bioelectromagnetics 15: 385-398.

Unknown. 2018. Follow-up report to the House of Commons Standing Committee on Environment and Sustainable Development on the Canadian Environmental Protection Act, 1999. 84 pp.

Westerdahl BB, Gary NE. 1981. Longevity and food consumption of microwave-treated (2.45 GHz CW) honeybees in the laboratory. Bioelectromagnetics 2: 305–314.

Wiltschko R, Thalau P, Gehring D, Niebner C, Ritz T, Wiltschko W. 2015. Magnetoreception in birds: the effect of radio-frequency fields. Journal of Royal Society Interface 12(103). doi: 10.1098/rsif.2014.1103.