

**Submission to U.S. Health and Human Services Request for Information on  
Electromagnetic Fields (EMFs), Radiofrequency (RF) Radiation, and  
Wireless Radiation Exposure  
Docket: HHS-OASH-2026-0397**

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**Environmental Protection Agency**

**U.S. Fish and Wildlife Service**

Federal Communications Commission

General

Science-based policy

Recommendations by Expert Groups

[The International Commission on Biological Effects of Electromagnetic Fields](#)

[The Santa Clara County California Medical Association](#)

[New Hampshire State Commission on 5G Health and Environment](#)

[Maryland State Children’s Environmental Health And Protection Advisory Council](#)

III. [Response to 6. What scientific evidence exists about potential adverse health effects caused by current exposure limits?](#)

The scientific references below cover a broad range of research topics, including:

- Cancer and tumor risk, including childhood leukemia and brain tumors.
- Reproductive health, fertility, pregnancy, and fetal development.
- Neurological effects and neurodegenerative diseases.
- DNA damage, genetic effects, oxidative stress, and other biological mechanisms.
- Children’s vulnerability and exposure from cell towers, wireless devices, and power lines.
- Effects on wildlife, pollinators, plants, trees, and ecosystems.
- The adequacy of current exposure limits and research on 5G, millimeter-wave, and emerging frequencies.

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## Perspective and Policy Expertise

I am Director of the Wireless and EMF Program at Environmental Health Sciences and a policy expert on the regulation of radio-frequency and non-ionizing electromagnetic fields in the United States. I have co-authored several [scientific papers](#) and authored the policy review [“U.S. policy on wireless technologies and public health protection: regulatory gaps and proposed reforms”](#) published in Frontiers in Public Health. The review examines the history of U.S. wireless technology regulation, identifies deficiencies in public-health and environmental oversight, and recommends reforms. My book Chapter [“Escalating Non-Ionizing Electromagnetic Fields from Telecommunications and Electricity: Comparing and Contrasting U.S. and International Policies and Approaches to Protecting Public and Environmental Health”](#) details how the US has fallen behind other countries in protecting the public from growing non-ionizing EMF exposures. I co-authored a paper on wildlife with other distinguished experts [“Flora and fauna—How nonhuman species interact with natural and man-made EMF at ecosystem levels and public](#)

[policy recommendations](#)” and the recommendations from these published papers are included in this submission with the full papers attached.

I also coauthored the paper “[Building Science and Radiofrequency Radiation: What Makes Smart and Healthy Buildings](#)” in Building and Environment after our presentations at the National Institutes of Health in Buildings Roundtable Conference. I co-authored the book Chapter “A new form of environmental pollution: Wireless and non-ionizing electromagnetic fields.” in [Environmental Health in Nursing, 2nd Edition](#).

I was a lead expert in the legal challenge to the FCC’s wireless radiation exposure guidelines in [Environmental Health Trust \(EHT\) et al. v. FCC](#), which resulted in the 2021 federal appellate court decision, mandating the FCC to explain why it had decided not to update its 1996 human exposure limits for wireless radiation. I served as Executive Director of EHT during the proceedings. I have since filed [well over 4000 scientific papers and reports](#) to the FCC. I now direct the [Wireless and EMF Program](#) at the scientific non-profit Environmental Health Sciences which is focused on advancing science based policies that protect health and the environment. We examine the science and policy of non-ionizing EMF, with a focus on [cell towers](#), [children’s vulnerability](#), [wildlife](#), as well as the EMF exposure [from power lines](#), and [data centers](#). We also provide [factsheets and policy resources](#) that translate scientific evidence into practical steps to reduce exposure, inform protective policies, and safeguard communities and ecosystems. We also publish [Environmental Health News](#), a news platform covering the latest science and policy on cell towers, cell phones, power lines, endocrine disruption, and other critical environmental health issues.

I also serve as a Special Expert to the [International Commission on the Biological Effects of Electromagnetic Fields](#) (ICBE-EMF), an international consortium of scientists, physicians, and researchers focused on the biological and health effects of non-ionizing electromagnetic fields.

[Read my bio here.](#)

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## Response to HHS Question 5 and 17

*What existing national and international exposure standards, guidelines, or regulatory frameworks should federal health agencies consider when evaluating the potential adverse health effects of human exposure to RF/EMF?*

*What scientific, technical, or regulatory changes by federal health agencies, if any, would improve the assessment, disclosure, and regulation of wireless radiation exposure?*

*How can federal health agencies improve coordination of EMF and RF radiation research? Please comment on potential roles for federal health agencies*

**Comment:**

**Why reform is needed:** Technology should be safe for all people, wildlife and the natural environment. The Federal Communications Commission's (FCC) current human exposure limits for radiofrequency (RF) radiation exposure applicable to cell towers, Wi-Fi networks, 4G, 5G and upcoming 6G are outdated, obsolete and inadequate to protect human health or the environment. Unchanged since 1996, FCC limits are primarily based on protecting against overheating of tissue, rather than the numerous adverse effects reported in hundreds of peer reviewed scientific studies which include increased cancer, genetic effects and impacts to nervous, immune, endocrine and reproductive systems. (More on the scientific evidence at [Response to 6. What scientific evidence exists about potential adverse health effects.](#))

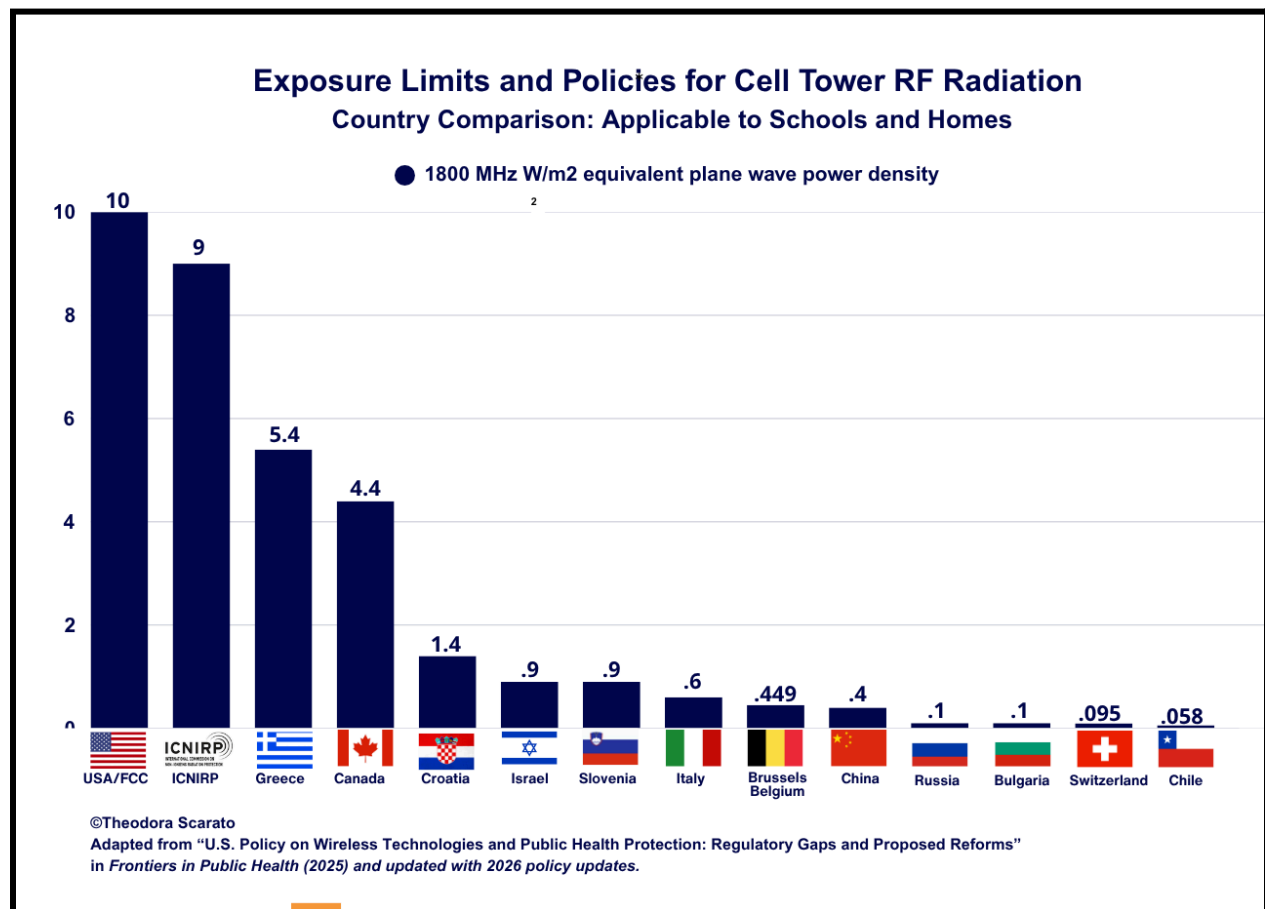
As detailed in Table 1 and [U.S. policy on wireless technologies and public health protection: regulatory gaps and proposed reforms](#) published in *Frontiers in Public Health*, the US regulation of wireless RF-EMF is deficient on numerous counts.

**Table 1: US Regulatory Framework for Wireless RF- EMF Radiation: Assumptions v. Reality**

| <b><i>US Regulatory Framework for Wireless RF- EMF Radiation: Assumptions v. Reality</i></b>  |                                                                                                                                                        |
|-----------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Assumed Element</b>                                                                        | <b>Reality</b>                                                                                                                                         |
| Regular review of exposure limits using totality of current science                           | ✗ Not regularly reviewed. Limits are unchanged, without proper review since 1996.                                                                      |
| Limits set to protect against health impacts from long-term exposure.                         | ✗ Limits are designed only to protect against heating effects from short-term, high exposure.                                                          |
| Limits have science based safety factors to protect children and babies.                      | ✗ Not based on research focused on children's risk. Limits are based on a large adult male.                                                            |
| Includes environmental protection (wildlife, trees, habitat)                                  | ✗ Not designed for wildlife, only for humans.                                                                                                          |
| Robust research by health and environmental agencies on EMF impacts to health and environment | ✗ No current research activities. NIH animal studies found "clear evidence" of a cancer link, but findings were dismissed.                             |
| Premarket safety testing of new technologies                                                  | ✗ Not required. 5G small cell networks with higher frequencies and unique antenna designs were fast-tracked without safety testing for health impacts. |
| Post-market surveillance to ensure cell phones are compliant with safety limits               | ✗ Minimal transparency on what surveillance exists or the findings.                                                                                    |

|                                                                                                         |                                                                                                                                                               |
|---------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Post-market medical and environmental surveillance to gather data on reports of effects                 | ✗ No reporting system. No ability to analyze data.                                                                                                            |
| Exposure limits for all the types of EMFs emitted from cell phones and wireless devices ( ELF, LED etc) | ✗ No federal safety limits exist for the magnetic fields or ELF emitted from wireless electronics or the LED from screens based on assessment of health risk. |
| Compliance testing reflecting real-world use                                                            | ✗ No. Tests do not require phones to be tested in direct contact with the body.                                                                               |
| Nationwide EMF level monitoring                                                                         | ✗ No national program to measure and monitor.                                                                                                                 |
| Annual compliance checks for towers/antennas                                                            | ✗ No such requirement exists.                                                                                                                                 |
| Public registry of all 4G/5G sites                                                                      | ✗ No centralized public database of all wireless network base station sites.                                                                                  |
| Oversight and enforcement for compliance of network infrastructure                                      | ✗ No federal program auditing sites.                                                                                                                          |
| Easy-to-understand consumer RF radiation info                                                           | ✗ No easy to find RF exposure information. Statements, if found, are technical and many lack clarity regarding recommended usage.                             |
| Safeguards and risk reduction policies for vulnerable groups                                            | ✗ No measures to reduce exposure to children and the medically vulnerable. No increased oversight for exposure at schools and daycare.                        |
| Transparency regarding exposures                                                                        | ✗ No requirement that locations of wireless sites be publicly posted. No online maps with permit information or RF levels reports.                            |
| Occupational health RF protection program                                                               | ✗ No program exists. No occupational exposure limit based on up to date science. Research and oversight activities were dismantled years ago.                 |

The U.S. is among the countries that allow for the highest levels of cell tower and wireless radio-frequency (RF) radiation in the environment due to the lack of up to date scientific review. As shown in the graphic below, many countries have environmental limits far more restrictive for sensitive areas such as daycares, schools and/or homes. However, the U.S. maintains a one-size-fits-all approach *without additional protections for sensitive populations*.



The Graphic above is adapted from my publication [U.S. policy on wireless technologies and public health protection: regulatory gaps and proposed reforms](#) published in *Frontiers in Public Health* shows the selected country's general public limit for 1800 MHz W/m<sup>2</sup> equivalent plane wave density specifically applicable to schools and/or homes. Switzerland and Italy's limits in Figure 2 apply to places of "sensitive use" such as apartment buildings, schools, hospitals, permanent workplaces, children's playgrounds, and where people stay for hours. **Biologically relevant changes have been documented at very low intensities, far lower even than these countries' more stringent limits. Thus, science based limits could be far more restrictive.**

Regarding the extremely low frequency EMF exposures from power lines, electric substations and electrical grid equipment and infrastructure, the United States has no federal safety standards, a critical regulatory gap, especially today when new 765 kV transmission lines are being proposed nationwide. Science and policy issues are detailed in the [Environmental Health Sciences' Report on Power Line EMF](#) attached. Although the U.S. EPA was developing health-based safety recommendations during the 1990s, its EMF health effects program was defunded before the assessment was finalized. Since then, no federal agency has assumed

responsibility for developing health-based exposure standards, nor has any agency reviewed the scientific evidence, or established a comprehensive framework to protect the public from long-term EMF exposure. IEEE and ICNIRP exposure limits often cited by power companies were developed primarily to prevent acute effects such as nerve stimulation and electric shock. They were not designed to protect against long-term outcomes including cancer or neurological disease. However many countries unlike the US have policies to mitigate power frequency EMF exposure far lower than industry limits.

**Table 2: US Federal Regulatory Framework for the Nonionizing ELF EMF Emitted From Power Lines, Substations and Electric Grid Infrastructure and Appliances**  
**Assumptions v. Reality**

| <b>US Federal Regulatory Framework for the Nonionizing EMF Emitted From Power Lines, Substations and Electric Grid Infrastructure and Appliances: Assumptions v. Reality</b>                        |                                                                                                                                                                                                   |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Assumed Element</b>                                                                                                                                                                              | <b>Reality</b>                                                                                                                                                                                    |
| Federal safety standards were developed to protect human health.                                                                                                                                    | ✗ No federal safety limits for magnetic or electric field power frequency EMF exist. EPA was defunded from bioeffect research in the mid 90s.                                                     |
| Agencies with health and environmental expertise review the current science to ensure safety for the public.                                                                                        | ✗ No federal agencies have shown any review of the science on ELF-EMF for decades.                                                                                                                |
| Agencies with wildlife and agriculture expertise have reviewed science to ensure safety for livestock, agriculture and wildlife.                                                                    | ✗ No comprehensive federal review to determine whether long-term EMF exposure is safe for wildlife, livestock, or agriculture, despite high voltage power lines being built on agricultural land. |
| IEEE and ICNIRP limits, referenced by the utility companies, protect against long term health effects like cancer or the reported effects of miscarriage, Alzheimer's and other biological impacts. | ✗ IEEE and ICNIRP limits for power frequency EMF are designed only to protect against effects from short term exposure such as the stimulation of nerves and muscles.                             |
| Industry IEEE limits protect people with medical issues, including those who have pacemakers or other implanted devices.                                                                            | ✗ IEEE explicitly states its standards are not intended to apply to patients under medical care and may not be protective for people using medical devices or implants.                           |
| Robust research by health and environmental agencies to investigate EMF impacts to health and environment.                                                                                          | ✗ No current research activities or experiments are reportedly being conducted by any federal agency.                                                                                             |
| Premarket safety testing for EMF emitted by high voltage transmission lines and substations.                                                                                                        | ✗ Never performed. When new higher power transmission lines such as 765 kV lines are proposed, there is no requirement to test for health effects.                                                |

|                                                                                                                    |                                                                                                                                                                                                                                                                         |
|--------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Requirement to model or disclose expected magnetic or electric field levels before construction.                   | ✗ No federal requirements to model, measure, or disclose EMF levels. Such requirements exist only in certain states or as conditions of individual permitting processes. They are generally not publicly shared                                                         |
| Nationwide EMF level measuring and monitoring                                                                      | ✗ No national program to measure and monitor EMF levels nationwide. Defunded in the 90s.                                                                                                                                                                                |
| Post-market surveillance to ensure utilities are maintaining EMF levels they presented in the application process. | ✗ No oversight. Utilities do not have yearly audits required by the federal government to show compliance. It's the honor system.                                                                                                                                       |
| Post-market medical and environmental surveillance to gather data on health or environmental effects.              | ✗ No reporting system. No surveillance system. No ability to analyze data as it is not collected.                                                                                                                                                                       |
| Oversight and enforcement for compliance of network infrastructure                                                 | ✗ No federal program auditing sites.                                                                                                                                                                                                                                    |
| No setbacks for schools or safeguards and risk reduction policies for vulnerable groups.                           | ✗ No measures to reduce exposure to children and the medically vulnerable. No increased oversight for exposure at schools and daycare.                                                                                                                                  |
| Transparency regarding EMF exposures from equipment and in nearby homes.                                           | ✗ No federal requirement that EMF exposure from grid equipment be publicly posted. No easily accessible online maps with permit information or EMF level reports are required. Technical information tends to be complicated for the general public to navigate.        |
| Occupational health EMF protection program                                                                         | ✗ No robust EMF occupational health program exists to characterize worker EMF exposures in various workplace settings or to provide oversight and support employers and employees in protections. Activities by occupational health agencies were dismantled years ago. |

## Identified Gaps, Deficiencies and Recommendations

**The US should develop the most protective human exposure limits and regulatory framework for non-ionizing EMF worldwide based on a public health and *risk mitigation approach*.**

HHS and relevant federal agencies should lead a coordinated interagency effort to restore independent research, systematically evaluate the full scientific evidence, and develop exposure limits that address chronic, cumulative, and non-heating effects, with protective safety margins for children, pregnancy, and medically vulnerable populations. For RF-EMF, as well as ELF-EMF, HHS should ensure an independent evaluation of the totality of the scientific evidence including cancer, genetic damage, oxidative and cellular stress, reproductive and fertility outcomes, pregnancy and fetal development, neurological and cognitive effects, sleep, endocrine and immune function, cardiovascular effects, and blood–brain barrier integrity. The evaluation should also address effects on wildlife, plants, and ecosystems, including pollinator health, animal navigation and migration, reproduction and development, plant growth, biodiversity, and ecosystem functioning. This effort should include regular, transparent scientific reviews and exposure limits and regulations specifically designed to protect wildlife, plants, and ecosystems.

These reforms must be supported by meaningful testing, oversight, transparency, and exposure reduction measures. Federal agencies should require premarket health and environmental safety assessments; modernize device compliance testing to reflect real-world use; conduct independent post-market audits; and establish nationwide exposure monitoring and systems for reporting suspected adverse health and ecological effects. Publicly accessible infrastructure maps, exposure data, clear labeling, and practical public education are needed along with measures to reduce exposures in homes, schools, daycares, and sensitive habitats. Federal policy should also support wired connectivity and lower-emission technologies. Further, a robust occupational health program is needed to protect American workers.

Below are my recommendations as detailed in my policy review paper [U.S. policy on wireless technologies and public health protection: regulatory gaps and proposed reforms](#) published in *Frontiers in Public Health*. I have added additional recommendations for ELF and other non-ionizing EMF exposures.

**Gap: A lack of agency activities investigating human health effects of wireless technology and non-ionizing EMF.**

***Reform: Reinvigorate national research activities.***

1. Reinstate a comprehensive national non-ionizing EMF bioeffects research program across key federal agencies with annual reporting.
2. Direct federal agencies to commission the National Academies of Sciences, Engineering, and Medicine to review the health and environmental effects of non-ionizing electromagnetic fields, including RF and ELF exposures, and issue actionable policy recommendations, research priorities, monitoring, and protection of children, workers, and ecosystems.
3. Direct the National Institute of Environmental Health Sciences (NIEHS) to conduct a comprehensive, transparent review of human, animal, and mechanistic evidence on the health effects of RF, ELF and other non-ionizing exposures, including chronic exposure

[The Wireless and EMF Program at Environmental Health Sciences](#)    [EHSciences.org](https://ehsciences.org)

and vulnerable populations. Prioritize evaluations of RF radiation and ELF magnetic fields for inclusion in the National Toxicology Program's Report on Carcinogens.

4. Ensure a thorough ongoing review of the scientific evidence, paired with targeted research activities to address critical data gaps and evaluate industry involvement.
5. Reestablish an interagency group to coordinate among federal agencies. All activities should be publicly posted along with agendas, priorities, meeting minutes and reports.
6. Expand research to encompass all artificial non-ionizing frequencies and new technologies, including, as just a few of the examples, power frequency ELF, charging systems, wireless power transfer, LED systems, satellite systems, the numerous types of wireless technologies in cars and mmWave -THz bands associated with emerging 6G technologies.

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**Gap: Human exposure limits are only designed to protect against short-term heating related effects.**

***Reform: Revise limits with an evidence-based approach that protects against effects of non-heating biological and long-term effects.***

1. Update exposure limits using quantitative risk assessments grounded in current scientific research to address adverse biological effects, including those from cumulative and long-term low-intensity exposures, applying an ecosystem-based approach.
2. Address signal characteristics (such as modulation) and exposure parameters (environment, metal, etc.) beyond frequency and intensity.
3. Apply safety margins sufficiently protective for children, fetal development during pregnancy, different developmental and medical sensitivities, ensuring safety factors consistent with limit-setting practices used for toxic and carcinogenic exposures.
4. Science based safety limits for health need to be developed for all artificial non-ionizing frequencies, including from charging systems, wireless power transfer, LED systems, satellite systems, and mmWave–THz bands associated with emerging technologies.
5. Develop wildlife-specific exposure limits and immediate policies to mitigate wildlife exposure and environmental exposures in ecologically sensitive areas.
6. Mandate periodic, independent scientific reviews of exposure limits and regulations through transparent processes and public participation. Conduct these re-evaluations annually, and also immediately upon the publication of critical research and the introduction of new technologies. The American public should not wait another 30 years to review its limits.

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**Gap: No nationwide measuring and monitoring program for environmental exposures**

***Reform: Establish a transparent national measuring and monitoring program to track environmental exposures from EMF emitting infrastructure.***

1. Measure and monitor EMF levels nationwide in rural, suburban and urban areas, prioritizing sensitive areas like schools and conservation areas, with publicly accessible data dashboard and yearly reporting.
  2. Install permanent, independently operated 24/7 monitoring stations to measure RF and EMF levels continuously, 24 hours a day, seven days a week, near cell towers and other wireless infrastructure, as well as near high voltage power lines, electric substations and other EMF emitting infrastructure prioritizing residential areas, schools, daycares, and ecologically sensitive areas. Publish time-stamped measurements on an accessible public dashboard, with automatic alerts and prompt investigation of exceedances. The public should be able to access all measurements, including going back in time to see time trends.
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**Gap: No premarket safety testing for new technologies.**

***Reform: Establish transparent premarket safety testing for new technologies and networks.***

1. Require premarket safety testing for health effects from chronic exposure for all new wireless technologies, networks and frequencies (such as 6G, satellite networks, smart meters, higher-frequency Wi-Fi etc.. ), and also for EMF emissions from proposed electrical grid infrastructure (such as high voltage 765 kV power lines) just as is required for drugs.
  2. Testing should address cumulative and combined exposures across frequencies, signals, and sources. This is particularly important for wireless devices and networks that incorporate multiple transmitters and can emit on several frequency bands simultaneously; evaluating each frequency separately may not adequately capture or characterize the effect of the combined exposure.
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**Gap: No post-market medical, health, and environmental surveillance.**

***Reform: Establish a transparent reporting system for suspected adverse health and environmental effects following the approach used in drug adverse-event reporting.***

1. Establish a national reporting system for physicians and other healthcare professionals to report suspected adverse health effects associated with RF-EMF exposure from consumer devices (phones, computers, etc.) and wireless infrastructure (cell towers, small cells, etc.).
2. Establish a parallel reporting system for physicians and other healthcare professionals to report suspected adverse health effects associated with ELF-EMF exposure from substations, high-voltage power lines, transformers, and other electrical grid equipment.

3. Establish an environmental reporting system for wildlife biologists, veterinarians, conservation professionals, and land managers to report suspected adverse effects on wildlife, plants, and ecosystems associated with EMF exposure, including observations near wireless infrastructure, power lines, and substations.
  4. Enable direct reporting by the public, allowing individuals to report suspected adverse effects through a simple, accessible online form, with telephone and mail alternatives.
  5. Create an accessible, searchable public database allowing anyone to easily look up a device by manufacturer and model or infrastructure by location and view anonymized reports, investigation status, agency findings, and corrective actions.
  6. Require public reporting of aggregate findings and agency investigations and responses.
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**Gap: Premarket and post-market compliance tests for RF-EMF emitting devices and networks do not reflect real-world usage patterns, environmental conditions, or today's users and exposed populations.**

***Reform: Modernize compliance tests for RF exposure from cell phones and wireless devices to reflect real world use patterns and all exposed populations.***

1. **Update standardized test positions to reflect foreseeable body contact and pressure.** Require evaluation of the range of positions in which phones are actually held, carried, or pressed against the body, including:
  - a. Carried in tight pockets, waistbands, bras, or other clothing that holds the device against the body.
  - b. Wedged between the head and shoulder, with simultaneous contact against the ear, cheek, and neck.
  - c. Pressed against a child's abdomen.
  - d. Angled so that an edge or two corners contact the body, rather than only a flat surface.
  - e. Held firmly against the head, accounting for compression of the external ear and variation in ear anatomy.
2. **Do not allow an artificial ear spacer to substitute for realistic head-contact assessment.** Require testing and validated anatomical simulations that account for phones to be pressed *directly against the skull*.
3. **Require anatomically realistic engineering simulations.** Use validated computational models to evaluate exposure across different ages, body sizes, anatomies, various tissue properties, and pregnancy stages. End reliance on a single simplified head or body model.
4. **Evaluate metal and accessories.** Assess reasonably foreseeable interactions with metal on, in, or near the body, including jewelry, eyewear, implants, clothing components, cases, and accessories. Address both altered exposures and interference with medical devices.

5. **Evaluate simultaneous exposures.** Assess concurrent cellular, Wi-Fi, Bluetooth, and other transmitters, including multiple devices used together and relevant background sources.
  6. **Test for realistic operating conditions.** Include weak-signal operation, sustained uploads, video calls, hotspot use, antenna switching, and other conditions that can change transmitting power and exposure.
  7. **Validate exposure-control functions.** Independently test proximity sensors, body detection, and power-management algorithms across foreseeable positions, accessories, and failure conditions.
  8. **Disclose exposure peaks and averaging.** Report spatial and temporal exposure distributions, localized hotspots, averaging periods, and uncertainty. Explain what the selected compliance metrics capture *and what they leave unassessed*.
  9. **Verify production devices and software changes.** Test independently purchased retail devices and require reassessment when hardware, firmware, or software changes could materially alter emissions or exposure controls.
  10. **Publish complete exposure and compliance evidence.** Disclose test distances, configurations, operating modes, device versions, measurement results, simulation assumptions, uncertainty, failures, and corrective actions.
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**Gap: Premarket and post-market compliance processes for RF-EMF emitting devices and networks are inadequate to capture non-compliant devices and networks and lack transparency and oversight.**

***Reform: Modernize oversight and compliance procedures and reporting frameworks.***

1. Establish routine robust post-market RF radiation compliance testing for all cell phones, RF emitting devices with all results and surveillance schedules publicly posted.
  2. Require testing of multiple units for each model before and after market release, not just one device per model.
  3. Devices tested should also include used, refurbished, and repaired devices. Evaluate whether this impacts RF exposure or compromises compliance, and requires corrective action.
  4. Update and standardize RF compliance procedures and reporting for cell towers and wireless network infrastructure. Develop clear oversight procedures to ensure recommended remediation is completed and that methodologies and measurement tools are empirically validated.
  5. Perform routine audits of emissions from networks and devices.
  6. All results, enforcement and corrective action measures publicly posted in an easy to navigate online platform.
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**Gap: A lack of transparency regarding locations of wireless infrastructure and device emissions as well as electric grid infrastructure .**

**Reform: Ensure publicly accessible information for locations of RF and EMF emitting infrastructure.**

1. Develop a national registry and database of all existing and proposed wireless network infrastructure installations (towers, 4G, 5G, etc.), including permitting and RF compliance data.
  2. Establish a single, easy-to-use national website with interactive mapping tools, used by all states and localities, that integrates RF measurements, infrastructure locations, and permitting records. Users should be able to enter an address and immediately view nearby installed and proposed infrastructure, with clearly distinguished map overlays. One click on a site should display its owner and operator, installation type, RF/EMF measurements and compliance records, permit applications and supporting documents, current review stage, approval status, public-comment deadlines, hearing dates, and agency contacts. Require timely updates so the public can track each proposal from initial application through approval, construction, and operation.
  3. Ensure RF complaints to the FCC and the agency's response are publicly available.
  4. Update the FCC's equipment authorization website so the public can easily search by device name, manufacturer, model, and not just FCC ID and find RF exposure results without navigating technical filings. Provide a plain-language summary showing reported SAR or power-density values, test distances and positions, simultaneous-transmitter evaluations, exposure-reduction instructions, and any compliance failures or corrective actions, with direct links to complete test reports.
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**Gap: A near complete lack of consumer awareness regarding exposure.**

**Reform: Inform the public on exposures and measures to reduce exposure**

1. Require RF and EMF exposure labeling on all wireless devices and electronics (including charging cables) *along with clear instructions on mitigating exposure at the point of sale and packaging.*
2. Provide robust public health agency guidance on minimizing exposure from all types of emitting devices, including cell phones, baby monitors, speakers, printers etc., as well as how to use safer alternatives such as Ethernet and corded connections rather than Wi-Fi and Bluetooth.
3. Launch a national, multilingual multimedia education campaign. Use television, radio, social media, videos, public-service announcements, websites, and printed materials to explain RF and EMF exposure sources, scientific findings and uncertainties, and practical exposure-reduction measures. Develop tailored materials for parents, children, educators, healthcare professionals, workers, and older adults. Address exposure at

home, school, daycare, work, and during sleep, including both wireless devices and ELF-EMF sources such as electrical equipment and power infrastructure.

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**Gap: No safeguards to mitigate risk to children and vulnerable groups**

**Reform: Implement measures to reduce exposures in sensitive areas.**

1. Prioritize wired networks, rather than wireless.
  2. Issue robust guidance to institutions and local governments on reducing RF exposure for infrastructure and land use planning, as well as in building networks and devices.
  3. Prohibit wireless infrastructure on or near schools, daycares, and critical wildlife habitats.
  4. Assess and mitigate daycare and school RF-EMF exposures, including replacing Wi-Fi with Ethernet, disabling unnecessary wireless transmitters, and keeping cell phones powered off when not needed. Assess and reduce ELF-EMF exposures in classrooms and childcare facilities. Correct wiring faults and unintended currents, and locate electrical panels, transformers, and major electrical equipment away from children's areas.
  5. Establish protective siting and setback requirements for high-voltage power lines, substations, transformers, and other major electrical infrastructure near homes, schools, daycares, healthcare facilities, and ecologically sensitive areas.
  6. Ensure accommodations are implemented in workplaces, educational institutions, public spaces, and residential areas as recommended by medical providers, including wired connectivity and access to spaces with mitigated/reduced RF-EMF and ELF-EMF exposure.
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**Gap: No oversight program or research focused on occupational exposures.**

**Reform: Safeguard workers with a robust occupational RF/EMF protection program.**

1. Establish a comprehensive occupational health program for EMF safety
2. Characterize and monitor exposure levels in a broad range of exposed occupations, from telecom, plastic industry, utilities, healthcare, military, to retail and education.
3. Establish standardized medical surveillance with mandatory recordkeeping and reporting to track worker health and exposure incidents, including overexposures.
4. Initiate R&D and innovation programs that prioritize low-EMF design and emission reduction in industrial and workplace technologies, focusing on minimizing unnecessary EMF exposures through improved engineering and manufacturing practices.
5. Require machinery and equipment to incorporate engineered EMF controls, shielding, and design features that minimize worker exposure, with verified performance and routine maintenance checks.

6. Issue comprehensive, site-specific guidance to minimize EMF exposure and mitigate risk, with special provisions for accommodating pregnant workers, medically vulnerable individuals, and persons with implants.
7. Ensure employer/worker training and education.

Note: See Theodora Scarato's presentation to the American Public Health Association Presentation: [Increasing Exposure to Non-Ionizing Electromagnetic Fields: The Case for Stronger Federal Oversight to Protect Workers](#).

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**Gap: A lack of education and training for medical professionals.**

***Reform: Develop medical education and training resources on EMF and health focused on prevention.***

- Incorporate education on RF and other non-ionizing EMF exposures into medical, nursing, and allied health curricula. Train healthcare professionals on exposure-reduction counseling for children, pregnant patients, workers, and medically vulnerable populations.
- Develop independent continuing medical, and health professional education on the scientific evidence, research gaps, exposure assessment, and practical exposure-reduction measures.
- Train healthcare professionals to take environmental and occupational exposure histories, including exposures from wireless devices, cell towers, power lines, and workplace equipment.
- Develop clinical guidance for evaluating and supporting patients reporting symptoms associated with EMF exposure, including assessment of other possible causes and appropriate referrals.
- Provide training on reasonable accommodations and reducing exposures in healthcare settings.
- Establish training on documenting and reporting suspected adverse effects to the national health surveillance system.

Note: The EMF Medical Conference 2021 Prevention, Diagnosis and Treatment of EMF Associated Illness that provided CEUs for doctors is available online [at this link](#). The EMF Medical Conference 2021 was hosted by the Electromagnetic Safety Alliance, Inc. <https://www.youtube.com/playlist?list=PL4rIYraNQvqCEibq4niZui4HuBHMwBuZG>

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**Gap: A lack of safer technology consumer options and research**

**Reform: Support research, innovation, and safer alternatives.**

1. Fund research on no/low EMF technology design.
  2. Provide economic incentives for industry to bring low/no technology to market.
  3. Ensure safer options are available to consumers. For example, require a plug-and-play option to connect devices with cables and Ethernet instead of wireless.
  4. Require manufacturers and developers to show they have researched and integrated EMF reduction strategies in technologies brought to market and network deployment.
  5. Launch a federal certificate program for no/low EMF technology and spaces.
- 

**Issue: Restricted state and local authority and inadequate public participation in infrastructure siting decisions**

Communities need meaningful authority to participate in the process and provide input to protect health, homes, schools, farmland, and ecosystems when decisions are made about wireless network infrastructure, high-voltage power lines, substations, and other electrical facilities.

**Reform: Restore state and local authority to protect communities from RF-EMF and ELF-EMF exposures.**

- Amend Section 704 of the Telecommunications Act to allow state and local consideration of RF health and environmental effects, including where facilities comply with FCC limits.
  - Strengthen local participation and authority in siting high-voltage power lines, substations, and other electrical infrastructure.
  - Empower local and state governments to establish protective setbacks to protect homes, schools, daycares, and sensitive habitats.
  - Enable communities to independently monitor and assess cumulative RF-EMF and ELF-EMF exposures, with publicly accessible results and costs paid by the responsible infrastructure owners and operators.
  - Require early public notice, accessible project information including EMF exposures, meaningful hearings, and sufficient time for independent review.
- 

**Gap: EMF limits do not exist that are designed to protect flora or fauna**

***Reform: Develop a regulatory framework to protect wildlife and habitat.***

The following recommendations are reproduced from [Flora and fauna—How nonhuman species interact with natural and man-made EMF at ecosystem levels and public policy recommendations](#) by B. Blake Levitt, Henry C. Lai, Albert M. Manville II, and Theodora Scarato (2025), pages 11–13 published in *Frontiers in Public Health*.

Environmental Protection Agency

- Define airspace as habitat: The Environmental Protection Agency (EPA), and all relevant agencies, should recognize nonionizing EMF as a biologically active form of pollution to air, ground and water. Airspace should be designated as “habitat” so EMF can be regulated like other pollutants. Many wildlife species, especially birds, bats, and insects, depend on airspace for migration, mating, foraging, and territorial defense. Defining airspace as habitat provides a legal foundation to assess cumulative EMF impacts as well as mitigate exposures.
- EPA should launch a dedicated research program to evaluate the biological and ecological impacts of radiofrequency (RF) radiation, treating it as an environmental pollutant akin to lead and pesticides.
- This program should include hazard identification, long-term exposure studies, cumulative risk assessments, and synergies with other environmental stressors with a focus on both human health as well as wildlife.
- Determine what ICRP flora/fauna protection for ionizing radiation can/does apply to nonionizing protection; institute regulations according to ethical and biological constraints.
- The EPA should ensure that rigorous independent science, separate from industry influence, guides the development of science-based, federally developed safety standards that protect the public and the environment.
- EPA should maintain at least one bioelectromagnetics scientist to guide any programs.

#### U.S. Fish and Wildlife Service

- Re-initiate the inter-agency USFWS/NTIA EIS collaboration that provides the framework/preliminary study design for a radiation research bird study, which has already been developed.
- Acknowledge/address EMF effects to migratory birds, federally listed fish and wildlife, and other protected plants and animals. Exposure standards for wildlife need to include guidelines for “avoiding or minimizing take” of birds/listed species to include exposure standards for wildlife from chronic, low-level exposures to EMF.
- In December 2021, the USFWS updated a migratory bird “take” rule which overturned a Trump administration rule (M-37050) that had allowed incidental take. Amend the 2021 “take” rule to include known/suspected impacts from EMF radiation on migratory birds.

#### Federal Communications Commission

- The FCC should respond to the Court mandate in EHT et al. v. FCC by requesting relevant expert agencies evaluate current scientific evidence on flora and fauna.
- FCC should request research in relevant agencies to address data gaps to address updating regulations to include wildlife protections for chronic, low-level exposures.
- The FCC should include thorough assessment of wireless technology effects in tower permitting processes and incorporate changes into their rulemaking regarding “effects of communication towers on migratory birds.”
- The FCC should work with USFWS to help private landowners develop ESA Section 10 Habitat Conservation Plans, especially in “critical habitat” where recovery goals for listed

[The Wireless and EMF Program at Environmental Health Sciences](https://ehsciences.org)    [EHSciences.org](https://ehsciences.org)

species have been designated and where impacts from cell towers and other radiation sources are at issue.

- The FCC should establish a measuring/monitoring program for transparency and environmental oversight to include a centralized, publicly accessible registry of all existing/proposed cell towers, 4G, 5G, and base station wireless facilities.
- The FCC should implement a nationwide EMF monitoring program that prioritizes ecologically sensitive areas where wildlife are vulnerable, e.g., national/state parks, forests, wildlife refuges, wetlands, coastal ecosystems, migratory corridors, and designated wilderness areas, along with human populations in other areas.
- The monitoring program should collaborate with environmental agencies to include environmental surveillance to track potential effects on wildlife, plants and trees. Monitoring species behavior, reproduction, and population trends in high-exposure areas would help identify risks and inform responsible infrastructure deployment, just as public health systems track human outcomes.
- FCC needs to bring its environmental review process in line with NEPA and restore public accountability. This includes developing NEPA-compliant procedures to assess cumulative environmental impacts on wildlife, insects, and flora.
- The agency should require documentation of categorically excluded (CE) facilities, such as small cells, and make environmental assessments, including RF compliance reports, publicly accessible.
- Regular, independent spot checks, particularly of RF levels pre- and post-construction, should be mandated for base station wireless facilities (cell towers, 4G and 5G).
- FCC should no longer allow industry advocates to self-determine the extent or need for environmental review. Further, public notice and comment periods must be meaningful, transparent and genuinely considered in the decision-making.
- FCC should implement NEPA reviews for all satellite systems, present and proposed.
- FCC should request congressional funding for at least one wildlife biologist on staff.

## General

- Pre-market testing: All relevant agencies should premarket test technologies within their purview before deployment to include a cost–benefit/cumulative effects analysis regarding their impacts.
- Pre-deployment environmental consultation and assessment: Federal agencies should conduct full environmental reviews prior to licensing and national buildout of major new technologies like 5G, 6G and beyond.
- Post-market environmental surveillance reporting systems: Biologists, local governments and the public should have accessible transparent mechanisms to report ecological impacts. Such a system would support timely investigations; help identify patterns and inform mitigation measures.
- Submit mitigation recommendations: The relevant federal/state/local agencies related to natural resources should be consulted on proposed networks and deployment of wireless facilities and submit recommendations on protecting sensitive species.

- Interagency coordination: Agencies should develop internal expertise in bioelectromagnetics, establish formal interagency coordination, convene regular meetings to include the FCC, EPA, USFWS, NTIA, and others. Collaboratively assess/manage EMF/RFR effects through joint research, analysis and advisement to policymakers.

## Science-based policy

Due to the many variables involved with biological effects—frequency, signal strength, duration, pulsing, modulation, resonance effects, and fluctuating wildlife presence, it is indeed a challenge to designate “safe” levels of radiation exposure in the environment, but a number of key steps can be taken to make facilities and habitats safer for wildlife. Compromises are understood as necessary but they must be science-based.

No one exposure limit can encompass protection for all flora and fauna given the variables, vast physical differences, and environments. What may protect one species may prove detrimental to another. It will be years before we have a general framework of frequency-dependent whole-body and-organ specific resonance factors per species. Thielens et al. (53); Toribio et al. (60); Jeladze et al. (61, 62) and Velghe et al. (102) have charted a computer modeled way forward for representative insect species that should be expanded to all taxa. There will always be unique absorption capacities per species and variations within those species. The best we can do at present is acknowledge the limitations of any broad approach and proceed accordingly over time to fill in the gaps.

One generalized method is to use the median of the low-intensity effects literature in Supplementary material 1 (see Box 2) to which most species are exposed today with an additional safety factor of 10 built in, knowing that this may not be enough to fully protect many avian, bat, and insect species capable of reaching very close proximities to infrastructure transmitters like small cells/towers. Until research is completed on resonance and other factors that clearly characterize risk to myriad species, we can only approximate exposure reduction based on data we do have for the most vulnerable species. It then becomes a question of what safety factor is most effective to potentially cover a broader range.

- Exposure limits: Set evidence-based RFR exposure limits and regulations for wildlife. As a starting point based on the median of the low-intensity studies in Supplementary material 1 with a 10-fold protection level, for wildlife this equals: SAR: 0.003 W/kg (3 mW/kg); Incident Power Density:  $\sim 0.005 \text{ mW/cm}^2$  ( $5.0 \text{ } \mu\text{W/cm}^2$ ). This lowers the ICNIRP and FCC exposure standards by a factor of more than 100.
- Resonance modeling: Evaluate species sensitivity and model whole-body and organ-specific resonance relationships per taxa; create a comprehensive database that is species- and frequency-specific, based on computer modeling matched with laboratory and/or field validation.
- Update compliance procedures: Tower/small cell compliance testing procedures must be updated to include RF exposure assessments at antenna height and in nearby wildlife habitats, not just at human-occupied ground levels.

- Robust environmental evaluations: Agencies need to conduct detailed environmental evaluations (e.g., EIS NEPA reviews that include mitigation) where new communication networks are proposed for wildlife/wilderness areas. Public consultation should be mandatory.
- Environmental impact statements (EIS): reviews should include proposed levels of electromagnetic radiation emissions as well as assessments of strategic design modifications to mitigate RF exposure including: directing antenna emissions away from critical wildlife areas like foraging, nesting, and denning sites; ELF mitigation could include designating appropriate locations for high-tension corridors and modifying existing wire configurations to reduce/cancel magnetic field intensity in sensitive habitats.
- Satellite systems subject to NEPA: All satellite systems, especially in low earth orbits like StarLink, must be subject to full NEPA reviews for effects to humans, wildlife, and atmospheric perturbations capable of adversely affecting habitat. Satellites have been categorically excluded from review from the start under the assumption that radiation reaching Earth was too low to matter. That is not accurate with the lower orbits used at today's satellite deployment scale occurring from many countries. Some migratory bird species fly at heights that increase their exposures significantly, especially from 5G networks. We are unfortunately going in the wrong direction with FCC rulings and political influence that exempt satellites from all NEPA review (105, 106).
- Targeted protections for wildlife and habitats: Wildlife does not have the luxury of EMF avoidance that humans do. Shielding and physical avoidance barriers around towers and high tension corridors are options to deter terrestrial ungulates, carnivores and small mammals but are not effective at blocking birds, bats, and flying insects. Only RF reduction can do that. Since the intensity of natural RFR is low (i.e., low noise level), and wireless communications use specific frequencies and modulations, reducing the emission intensity should have little effect on signal-to-noise detection by a sensitive receiver species.
- Setbacks in federal parkland and state-protected areas: Enhanced, species-specific targeted protections for wildlife and habitats should include: Minimum of 1,500 feet (457 m) setbacks between antennas and sensitive wildlife habitats to minimize ecological disruption (107, 108). This is particularly critical for areas such as National Audubon Society Important Bird Areas, ESA-designated critical habitats, designated wilderness areas, and federally listed bat hibernacula, requiring regulatory action by the FCC.
- Establish low- to no-EMF zones: Low- and no-EMF areas can protect important wildlife habitats and ecologically sensitive areas, especially during migration and mating seasons. These include designated wilderness areas, critical habitats, national parks, preserves and monuments, national historic sites, national forests and wildlife refuges, and world heritage sites among others.
- Remove/restrict existing infrastructure: In particularly sensitive areas containing endangered species, removing or restricting new wireless development may be needed. 5G and 6G's use of higher-frequency sub-millimeter/millimeter waves that pose heightened risks to sensitive taxa, especially insects, should be prohibited in ecologically sensitive areas. Insects are food supplies for everything else. This will require coordinated involvement from the FCC, USFWS, NPS, USFS, BLM, ACORE, and others

will need to be key players in these efforts including state-level park and wildlife management agencies.

- Barriers, radiation patterns, and others: Inexpensive mitigation measures include: maximizing the distance between wildlife and EMF sources with barriers, re-design of transmission radial plots away from sensitive habitats, and powerline placement on pylons to reduce magnetic fields near corridors can all help mitigate effects to wildlife. Regarding avian protection, information for the electric utility and communications industries is available through the Avian Power Line Interaction Committee (APLIC) (109, 110).
- Wildlife radio tracking: Radio tracking gear attached to wildlife by researchers, wildlife professionals, animal trackers, and others use pulse modulated RF in communication with satellites and can cause adverse effects to animal health as well as interfering with magnetoreception, behavior, hunting and reproduction, and can cause tissue damage over time (111, 112). Wildlife should not be unnecessarily enlisted as inadvertent research subjects or for human curiosity/entertainment. Non-invasive tracking methods should be prioritized over telemetry when possible, safer technologies need to be designed, and telemetry tracking gear more carefully assessed by state/Federal agencies that use/permit such gear (e.g., NPS, USFWS, USFS, BLM, ACORE, and NOAA-Fisheries). Best management practices should be used, including configuring devices to minimize EMF emissions especially to the brain, keeping radio telemeters in sleep mode where feasible, reducing the amount of tracking gear and the number of target animals used, as well as lowering the transmission times/rates. Tagged animals should be monitored for health and behavioral effects (111). Pertinent agencies that use such gear, as well as the Federal Trade Commission, could provide updated consumer tips to scientists regarding telemetry use (113). State veterinary departments should be made aware of the potential impacts from radiation before issuing permits needed by wildlife researchers to conduct their tracking studies on State and private lands.
- As low as reasonably achievable (ALARA): The ALARA Principle should follow science-based thresholds (114), minimizing exposure levels wherever possible. In practical terms, this means that whenever a new tower or wireless facility is proposed, regulators, network engineers, and decision-makers must ask: "Is the radiation truly as low as it can be?" This question must guide every aspect of infrastructure planning, including placement, design, transmission power densities, frequencies used, time-of-use relative to wildlife presence, migration/reproduction timeframes and more. ALARA alone, however, is not enough since no formal definition of what ALARA means for wildlife currently exists. Without scientifically established exposure limits, industry players may claim they are already meeting ALARA, when they are in fact greenlighting harmful exposures. To truly protect ecosystems, we must develop robust, science-based limits grounded in a comprehensive understanding of biological impacts across species and habitats.
- Technologies designed with wildlife in mind: New technologies and communication networks need to be designed with wildlife protection as a priority. Supported by the scientific evidence, there is growing scientific momentum toward incorporating

environmental considerations into the design and deployment of communication technologies (115).

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**Importantly, the federal government should not wait until science based limits have been developed to implement policies. Measures to reduce public and environmental exposure should be immediately implemented. Here is a list of recommendations by expert groups.**

## **The International Commission on Biological Effects of Electromagnetic Fields**

The International Commission on the Biological Effects of Electromagnetic Fields (ICBE-EMF) is an independent, multidisciplinary consortium of scientists, medical doctors, and professionals specializing in the biological and health impacts of non-ionizing electromagnetic fields. The commission's primary mission is to provide science-based recommendations that extend beyond numerical exposure guidelines, aiming to protect human and environmental health from potential harms associated with EMF exposure.

ICBE-EMF Recommendations in the [2026 Position Statement On Children's Health And Electromagnetic Fields](#)

### **Recommendations For Governments**

- Update national exposure limits on wireless, power frequency, and other non-ionizing EMF to reflect current scientific evidence and to ensure protection against biological effects.
- Fund independent research on long-term, cumulative biological and health effects of non-ionizing EMF.
- Require independent pre-market safety testing and independent post-market surveillance for the health effects of wireless and EMF-emitting devices.
- Ensure wireless radiation compliance tests for cell phones, Wi-Fi laptops and other RF radiation-emitting devices reflect children's physiology and the way they use devices today, in direct body contact.
- Halt the introduction of new technologies until rigorous pre-market safety testing is performed.
- Inform families about the substantial science indicating health risks and educate them on ways to reduce exposures from cell phones, wireless devices, electronics, and other sources of EMF.
- Adopt a risk mitigation approach with strong policies that reduce children's daily exposure at home and school and limit their use of wireless devices.
- Promote industry innovation for the design and manufacture of safer technologies, including wired networks, low-emission designs, and devices that minimize user exposure.
- Low EMF spaces must be established in schools as a priority.

### **A Safer Classroom: EMF Mitigation Steps For Schools To Protect Children, Teachers, And Staff**

- Replace all Wi-Fi networks with hardwired, shielded Ethernet internet connections.
- Purchase laptops and tablets with Ethernet capability, and with easy steps to disable wireless antennas so that computers connect to the internet with Ethernet only.
- Require that all cell phones be powered off for the entire school day and stored in a Faraday box or other shielded storage to reduce unnecessary RF exposure and minimize classroom distractions.
- Require that all devices and technology equipment used in schools have wireless transmitters (intentional radiators) disabled, ensuring that no wireless radiation sources operate within school buildings.
- Provide wired telephones for personnel in all classrooms
- Educate students, staff, and families on the risks of wireless and EMF exposure and how to reduce exposure.
- Minimize ELF exposures by ensuring adequate grounding, use of shielded cabling, twisted wiring, and devices with low ELF emissions.
- Ensure students are at a distance from electrical equipment and charging stations.
- Prohibit cell towers/base stations and other wireless emitting antennas on or near school property as is already the policy in some countries and U.S. school districts.<sup>165</sup>
- Prohibit high-voltage power lines and electrical substations on or near school property.
- School boards should maintain a team that can routinely conduct transparent, independent real-time EMF measurements (including body-worn dosimeters) in classrooms, playgrounds, and sports fields to ensure the lowest possible levels are maintained.
- Continuously mitigate as required to ensure the above principles are adhered to.

### **The Santa Clara County California Medical Association**

The [Santa Clara County Medical Association](#) has investigated this issue for years, publishing several scientific articles with recommendations.

In 2024, they released Best Practices for Technology in Schools. A key solution to reduce health risk to children is for schools to connect students to the internet via safer corded Ethernet connections, instead of Wi-Fi. They recommend the minimization of Wi-Fi exposure in the classroom and highlight the need to restrict cell towers near schools.

Ensure educational curriculum for students and staff on how and why to reduce wireless radiofrequency RF radiation exposure.

Measures to reduce personal exposure include:

- Prefer speaker phone and text rather than voice call.
- Put devices in airplane mode when not in use.
- Carry phones in backpacks, etc., not on the body.
- Switch devices to airplane mode when not in use.
- Avoid or strictly limit the use of Virtual Reality headsets.

Mitigate RF and non-ionizing EMF exposure in classrooms by choosing low or no RF-emitting devices and technology infrastructure.

- Install and prefer hard-wired ethernet connections.

- Wi-Fi routers, devices, printers and screens in the classroom should have timers and/or easy access on-off buttons or remotes so they can be turned off when not in use.
- Decrease router power and locate routers as far away from students as possible. Do not place them overhead.
- Disable 2.4 GHz Wi-Fi and use only 5GHz for classrooms
- Choose routers which are only on-demand (i.e. only transmit when in use.)
- Professionally measure RF before and after mitigation steps.
- Consider a Wi-Fi Free Zone on campus with signs posted to turn off phones.
- Avoid installation of smart meters on school premises.
- Implement blue light reduction methods such as apps, blue light computer covers or blue light glasses.

Implement classroom strategies to reduce wireless radiation:

- Pre-download materials, then disable wireless antennas (Bluetooth, GPS, cellular, and Wi-Fi) and use airplane mode.
- Prefer books instead of computers or tablets.
- Keep tablets and computers on a table and off students' laps

Implement measures school and district wide to mitigate risk. Examples include:

- Establish and promote cell phone-free school policies.
- Promote tech-free breaks in classrooms.
- Consider a policy to restrict installation of cell towers on or within 1640 feet of school property.
- Develop and distribute state-level policies and/or guidance for schools on RF and technology safety.
- Educate school nurses and launch monitoring program: School nurses need to be educated on this issue and can maintain a monitoring and reporting program for EMF exposure-related health symptoms (headaches, nausea etc.).

## New Hampshire State Commission on 5G Health and Environment

In 2019, the New Hampshire government passed House Bill 522 "An act establishing an expert commission of physicians, engineers and representatives of state government and agencies to study the environmental and health effects of evolving 5G technology." The Commission released its [Final Report on Commission to Study the Environmental and Health Effects of Evolving 5G Technology](#) in 2020 with findings that safety assurances for wireless technology "come into question because of the thousands of peer-reviewed studies documenting deleterious health effects associated with cellphone radiation exposure." The Commission recommended 15 measures to reduce wireless exposure and ensure accountability.

"The objective of those recommendations is to bring about greater awareness of cell phone, wireless and 5G radiation health effects and to provide guidance to officials on steps and

policies that can reduce public exposure. We also recommend partnering with our federal delegation to facilitate the reevaluation of radiation exposure guidelines and policies by federal agencies (i.e., the FCC, FDA, NASA, NOAA, FAA, EPA, etc.) to protect people, wildlife, and the environment from harmful levels of radiation.”

New Hampshire State Commission on 5G Recommendations to the Governor:

- A resolution to US Congress to require the FCC to commission an independent health study on wireless health effects and to review safety limits.
- Engage agencies with ecological knowledge to develop RF-radiation safety limits that will protect the trees, plants, birds, insects, and pollinators.
- Under the National Environmental Policy Act, FCC should do an environmental impact statement as to the effect on New Hampshire and the country as a whole from 5G and the expansion of RF wireless technologies.
- New measurement protocols needed to evaluate high data rate, signal characteristics associated with biological effects and summative effects of multiple radiation sources.
- New Hampshire schools and libraries should replace Wi-Fi with hardwired connections.
- Require setbacks for new wireless antennas from residences, businesses, and schools.
- Cell phones and wireless devices should be equipped with updated software that stop cell phones from radiating when positioned against the body.
- Support statewide deployment of fiber optic cable connectivity with wired connections inside homes.
- Establish RF-radiation free zones in commercial and public buildings
- New Hampshire health agencies to educate the public on minimizing RF exposure with public service announcements on radio, television, print. “Warnings concerning the newborn and young as well as pregnant women”
- The state should measure RFR post maps for the public.
- Require 5G structures to be labeled for RFR at eye level and readable from nine feet away.
- RFR signal strength measurements for cell sites should be done by independent contractors.
- NH professional licensure to offer education so home inspectors can include RF intensity measurements.
- Warning signs to be posted in commercial and public buildings.

## **Maryland State Children’s Environmental Health And Protection Advisory Council**

The Maryland State Children’s Environmental Health and Protection Advisory Council, whose 19 member Commission includes experts in public health, pediatricians, epidemiologists, state health and environment agencies and legislators, sent a [Letter to the Federal Communications Commission on the need for stronger regulations](#), issued a [“Wi-Fi in School Report”](#) recommending schools reduce wireless exposure , and released [“Guidelines to Reduce Cell Phone and Electromagnetic Field Radiation”](#) for parents.

## Examples of Maryland State Children's Environmental Health And Protection Advisory Council's Recommendations for Parents

Cell phones, wireless devices, and WiFi routers emit RF radiation all the time, even when you are not using them. Even in standby mode, your phone emits RF radiation because it is constantly searching for service or new messages. If you do not need your cell phone, simply turn it off or put it in airplane mode. This applies to all other wireless devices, including laptops, tablets, video gaming consoles and smart speakers.

### Around the Home:

- Replace cordless phones with corded home phones.
- Unplug cordless phones when not in use (if you have at least one corded telephone in the house, you can always be reached, even if the cordless phone is off at night).
- Remove electronics from the bedroom, especially around your bed and the crib.
- Avoid sleeping with electric blankets and heating pads; if you use an electric blanket to preheat your bed, unplug it before sleeping. If you only turn it off, the electromagnetic field will still be present.
- Do not stand close to a microwave oven when it is on or let your child press their face up to it watching the food cook.

### Cell Phones

- Try to keep devices, especially cell phones, away from the head and body. Keeping them an arm's distance away significantly reduces exposure.
- When you are talking on a cell phone, use the speakerphone to reduce exposure to your head.
- Avoid carrying your phone against the body like in a pocket, sock, bra, or spandex pants. Cell phone manufacturers cannot guarantee that the amount of radiation you are absorbing will be at a safe level.
- Make only short or essential calls on cell phones so that you minimize your daily exposure.
- Use text messaging rather than voice calls when possible.

### Laptops and Computers

- Choose wired Internet (ethernet cable modems) at home instead of wireless systems, if possible.
- Place WiFi routers as far away from children as possible.
- Consider using a switch to shut down your wireless router when it is not in use.

## Response to 6. What scientific evidence exists about potential adverse health effects caused by current exposure limits?

Hundreds of published studies report biological effects and associations with adverse health outcomes from RF-EMF and ELF-EMF exposure, far more than can be detailed in this comment. These studies span epidemiological investigations, clinical observations, laboratory research, and case reports. I have attached several papers documenting this evidence.

The following examples illustrate the research that HHS should consider when evaluating whether current exposure limits adequately protect health.

## RF-EMF from cell towers and wireless infrastructure

A [2022 review](#) examined published peer-reviewed research on people living near cell towers and wireless antenna sites. The majority of studies reported effects, primarily radiofrequency sickness, cancer, and altered biochemical markers.

In July 2021, the European Parliament released the commissioned report [“Health Impact of 5G”](#), which concluded that widely used RF frequencies, 450–6000 MHz, are likely carcinogenic to humans and may adversely affect male fertility and early development, including embryos and newborns.

**Sleep:** An [experimental study](#) found that individuals with specific gene variants who are exposed to 5G frequencies experienced changes in their brain wave activity during sleep. A study examining the impact of baby monitor RF on sleep quality found exposed adults experienced [significantly reduced sleep quality](#) and changes in EEG readings of brain activity during Non-Rapid Eye Movement (NREM) sleep.

**Colorectal cancer:** A Kaiser Permanente research team is investigating cell phone radiation and colorectal cancer. Studies are ongoing, however they presented preliminary findings at the International Society of Environmental Epidemiology Conference in a poster entitled, [“Is Cellphone Carrying Below the Waist \(Exposure to Non-Ionizing Radiation\) Contributing to the Rapid Rise in Early-Onset Colorectal Cancer?”](#) Their analysis reports that people who carried a phone on the left side for more than 30,000 hours were 12 times more likely to develop a tumor on that side of the colon.

**Brain and Thyroid Cancer:** The International Agency for Research on Cancer (IARC), a part of the World Health Organization (WHO), [classified](#) cell phone radiation as possibly carcinogenic to humans (Group 2B) in 2011 based on evidence linking heavy cell phone use to cancer. Today, numerous scientists state the scientific evidence has increased to the point that RF radiation [would be classified](#) by IARC as a “probable” or “proven” human carcinogen if re-evaluated based on current research. [Yale School of Public Health](#) has linked cell phone use to thyroid cancer. Published [case reports](#) and [case-control](#) studies have documented that women who carry cellphones in the bra have elevated breast cancer risk.

**Impacts to the Reproductive System:** A large body of [human](#) and [animal](#) studies consistently report that wireless radiation can impact sperm. Documented impacts include reduced sperm count, motility, and concentration; DNA damage; altered structure; and higher rates of erectile dysfunction. A [literature review](#) on the effects to male reproductive hormones concluded testosterone reduction. Reproductive impacts are not limited to males as laboratory studies [on female animals](#) link exposure to damage to ovarian follicles, disrupted cycles, and adverse effects on early embryonic development.

**Genetic Impacts:** A review of [over 500 studies](#) on genetic impacts published in Frontiers in Public Health found that a substantial body of scientific research has reported genetic damage from wireless radiation exposure in both humans and animals.

**Brain Activity:** The brain is particularly sensitive to wireless radiation exposure. A [National Institutes of Health study](#) found that cell phone use altered brain activity, changing glucose metabolism in regions closest to the phone's antenna.

**Memory Damage:** In a [European study of adolescents](#), researchers directly estimated the amount of RF radiation absorbed by the brain and found that higher cumulative brain dose from cell phone use over just one year was associated with damaged memory. The effect was specific to figural memory and to the brain regions on the side of the head most exposed during phone calls, supporting a dose–response relationship rather than an effect of screen time alone.

**Developmental Delays:** A [recent study](#) that directly measured RF radiation levels in the home environment found that children with higher exposure scored significantly lower on gross and fine motor skills and showed poorer performance in problem-solving and personal-social development compared to children with lower exposure.

Animal studies consistently show that wireless radiation exposure can impact [the blood brain barrier](#), [impact brain development](#) and [damage brain cells](#), particularly in brain regions critical for learning and cognition, including [the hippocampus](#), with several researchers [concluding that](#) such structural damage may lead to behavioral changes and long-term neurological effect.

**Impacts to the Endocrine System:** Studies have reported that the endocrine system, which regulates hormones, can be disrupted by wireless and EMFs. [Research](#) has found impacts on thyroid gland activity, adrenal function, and corticosterone levels, a hormone central to the body's stress response. This is important because hormones are central to brain development, metabolism, reproduction, and the body's stress response. Experimental [animal studies](#) have found that prenatal exposure led to a decrease in rats' estrogen and progesterone hormone levels, impacted the size of the rats' ovaries, and reduced the number of developing follicles.

**Lower Exposure does not mean safe:** While Bluetooth radiation is much lower than that of a cell phone to the head, this does not mean it is safe. [Research](#) by Yale University scientists found that exposure to wireless radiofrequency (RF) radiation at Bluetooth frequency and low power – approximately 4,000 times lower (0.025%) than the FCC's current allowable limit for human RF exposure interfered with neurodevelopment and increased the expression of autism-related genes in laboratory models of the fetal brain. A [study](#) published in the journal Scientific Reports found that prolonged daily use of Bluetooth headsets was “strongly linked” to an increased risk of developing thyroid nodules.

### **EMFs can amplify other toxic exposures.**

We are exposed to numerous environmental pollutants, such as air pollution, pesticides, heavy metals, and chemicals, and research shows that non-ionizing EMFs can interact with these toxins to increase their harmful effects. Studies have found that exposure can intensify the

biological impacts of substances like lead, pesticides, and air pollution, leading to greater inflammation, immune disruption, neurobehavioral effects, and increased toxicity than either exposure alone.

#### A Sampling of Studies on Combined Exposures

##### **Black Carbon**

[López-Martín et al. \(2023\)](#) in Sensors reviewed the impact of EMFs and wireless on cell cultures and reported that black carbon particles and/or radiofrequency electromagnetic fields increases toxicity, raising inflammatory responses, activating apoptosis, and accelerating cell damage. This means that in polluted air, especially during thermal inversions, when dirty air gets trapped close to the ground, wireless signals might worsen the harmful health effects of air pollution by making cells more inflamed or damaged.

[Sueiro Benavides et al. \(2023\)](#) in Science of The Total Environment reported that combined exposure of HL-60 human promyelocytic cells to black carbon particles and 2.45 GHz radiofrequency induced oxidative stress, and enhanced cell toxicity in the promyelocytic cell line.

[Sueiro Benavides et al. \(2021\)](#) in Science of the Total Environment reported on an in vitro study that found black carbon particles, found in air pollution, combined with 2.45 GHz radiofrequency exposure combined induced cell damage and an inflammatory response, activating apoptosis (programmed cell death) and accelerating cell toxicity in the RAW 264.7 macrophage cell line.

##### **Lead**

[Byun et al. \(2013\)](#) in PLOS ONE reported that heavy cell phone use was associated with increased ADHD symptom risk in children, but this effect was limited to those with higher blood lead levels, suggesting a combined toxic interaction between RF exposure and lead.

[Choi et al. \(2017\)](#) in Environmental Research reported that while no association was found between prenatal RFR exposure and child neurodevelopment impacts during the first three years of life; however, a potential combined effect of prenatal exposure to lead and mobile phone use was suggested. Among children whose mothers had high blood lead levels during pregnancy, a higher average maternal calling time was associated with an elevated risk of low Psychomotor Development Index scores up to 36 months. Similarly, greater calling time or frequency was linked to declines in the Mental Development Index.

[Ansarihadipour & Bayatiani \(2016\)](#) in Iranian Red Crescent Medical Journal reported that lead in the presence of EMF exacerbated the oxidative damage to plasma proteins in human blood samples.

##### **Atrazine**

[Rajkovic et al. \(2010\)](#) in Archives of Environmental Contamination and Toxicology reported that peripubertal male rats exposed to both the endocrine-disrupting herbicide atrazine and power-frequency EMF showed significant degranulation of cutaneous mast cells, with combined exposures producing stronger effects.

##### **Phthalates**

[Chen et al. \(2021\)](#) in Ecotoxicology and Environmental Safety reported that combined exposure to Di (2-ethylhexyl) phthalate (DEHP) and 50 Hz magnetic fields (MF) enhanced proliferation of human amniotic cells.

“Given that both MF and DEHP are ubiquitous environmental contaminants, the adverse effect of co-exposure at “safe levels” should not be underestimated. In this study, we detected that co-exposure to under-threshold MF and DEHP could significantly promote FL [human

amniotic] cell proliferation, suggesting that certain chemical and physical environmental stimuli at “safe-level” could induce synergistic effect indeed. Considering that abnormal cell proliferation was related to the occurrence and development of some diseases, the combined effect on FL cell, a representative cell from the reproductive system, could provide clues for further research on [reproductive toxicity](#).”

### **Caffeine**

[Panagopoulos \(2020\)](#) in General Physiology and Biophysics reported that human lymphocytes exposed to RF radiation at levels well below ICNIRP limits showed chromatid-type aberrations comparable to extremely high caffeine doses, and that combined exposure (RF radiation plus caffeine) produced dramatically higher genotoxic chromosome damage.

### **Fructose**

[Tripathi et al. \(2023\)](#) in Biomedical and Environmental Sciences reported that combined cell phone RF radiation exposure and high fructose intake disrupted metabolic regulators in growing rats. “Conclusion: The findings suggest that the combination of EMF exposure and fructose consumption during childhood and adolescence in Wistar rats disrupts the closely interlinked and multi-regulated crosstalk of insulin receptor signals, mitochondrial OXPHOS, and the antioxidant defense system in the hypothalamus and liver.”

### **Gold Nanoparticles**

[Jooyan et al. \(2023\)](#) in Chemosphere reported that RFR increased metabolic death in chinese hamster ovary cells treated with gold nanoparticles.

### **Ionizing Radiation**

[Panagopoulos \(2024\)](#) in General Physiology and Biophysics reported that cell phone radiation induced genotoxic effects and significantly amplified gamma radiation, induced chromosome damage in human cells at 136 times below ICNIRP’s limit.

[Soffritti et al. \(2016\)](#) in International Journal of Radiation Biology reported that lifelong exposure to 50 Hz magnetic fields combined with γ-radiation promoted carcinogenesis in rats. These results call for a re-evaluation of the safety of non-ionizing radiation.”

[Soffritti et al. \(2016\)](#) in American Journal of Industrial Medicine reported synergism between 50 Hz magnetic fields and formaldehyde in producing carcinogenic effects in male rats.

[Soffritti and Giuliani \(2019\)](#) in Basic & Clinical Pharmacology & Toxicology reported on their large scale animal studies finding that both 50 Hz magnetic fields and 1.8 GHz GSM radiofrequency radiation demonstrated carcinogenic potential.

[Obajuluwa et al. \(2023\)](#) in Egyptian Journal of Basic and Applied Sciences reported that co-exposure to 5 GHz router radiation and computed tomography (CT) scans produced heightened neurotoxic ( impairments in spatial working memory and exploratory behavior) cytotoxic, and genotoxic effects in male rats compared to CT alone.

[Khodamoradi et al. \(2022\)](#) in Biochemistry and Biophysics Reports reported that combined gamma radiation and Wi-Fi exposure “can increase the number of double-strand break DNA in peripheral blood lymphocytes to exposure of gamma-ray to 72 h after [technetium](#) injection in the rat.”

[Cao et al. \(2009\)](#) in Journal of Toxicology and Environmental Health Part A reported that the combination of EMF and γ-ray exposure resulted in a synergistic effect by triggering stress response, which increased reactive oxygen species.

### **EthylNitrosourea (ENU)**

[Lerchl et al. \(2015\)](#) in Biochemical and Biophysical Research Communications found tumors of the lungs and livers as well as lymphomas to be significantly elevated in mice prenatally

exposed to ENU, a chemical that causes cancer, replicating the results of an earlier study by [Tillman et al. \(2010\)](#).

“Our study confirms and extends the previously published observations of tumor-promoting effects of life-long RF-EMF exposure.”

“The fact that both studies found basically the same tumor-promoting effects at levels below the accepted (and in most countries legally defined) exposure limits for humans is worrying. Although animal experiments are generally not easily transferable to the situation in humans, the findings are a very clear indication that – in principal – tumor-promoting effects of life-long RF-EMF exposure may occur at levels supposedly too low to cause thermal effects.”

“Our findings may help to understand the repeatedly reported increased incidences of brain tumors in heavy users of mobile phones.”

[Tillmann et al. \(2010\)](#) in International Journal of Radiation Biology reported that lifelong RF exposure enhanced lung tumour incidence and metastasis in ethylnitrosourea-pretreated mice, suggesting a cocarcinogenic potential.

Multifrequency Non-ionizing EMF

[Wang et al. \(2022\)](#) in Ecotoxicology and Environmental Safety reported that combined 1.5 and 4.3 GHz microwave exposure impaired spatial learning and memory abilities and impacted hippocampal structure.

[Zhao et al. \(2022\)](#) in International Journal of Molecular Sciences reported that multi-frequency microwave exposures (1.5 and 4.3 GHz) produced immune suppressive responses.

[Zhu et al. \(2021\)](#) in Scientific Reports reported that 1.5 and 4.3 GHz microwave exposure impaired cognition and altered hippocampal structure in rats. Combined exposure to both frequencies caused more serious injuries.

### Nicotine

[Emre et al. \(2021\)](#) in South East European Journal of Immunology reported that 900 MHz RF-EMR alone induced harmful effects in human fetal amniocytes, and the combination with nicotine further increased apoptosis and necrosis.

### Examples of research on cell towers and other RF-emitting infrastructure

- **Iraq:** [Hussain et al. \(2026\)](#), published in *Advances in Applied Biological Research*, found significantly more nonspecific symptoms, including headaches, fatigue, and sleep disturbance, among adults living close to mobile telephone base stations than among those living farther away. The authors concluded, “It is sensible that mobile telephone base stations be located at least 500 meters from the houses of inhabitants.”
- **Malaysia:** [Chokeli et al. \(2026\)](#), published in *Scientific Reports*, found that primary school children attending schools closer to mobile phone base stations had significantly higher frequencies of micronuclei, a biomarker of DNA damage and genomic instability, than children attending schools farther away.

- **Iraq:** [Al Musawi and Mahmud \(2026\)](#), published in the *Malaysian Journal of Nursing*, found that adolescents living closer to cell phone towers reported significantly higher rates of symptoms, including headaches, sleep disturbances, fatigue, dizziness, poor concentration, and memory problems.
- **India:** [Salio et al. \(2025\)](#) surveyed residents living within 300 meters of mobile phone base stations. They reported more symptoms across four categories—mood-energy, cognitive-sensory, inflammatory, and anatomical—than residents living more than 400 meters away.
- **Germany:** [Gulati et al. \(2024\)](#) found significantly higher rates of chromosomal aberrations, indicators of genetic damage, among residents living near mobile phone base stations.
- **Sweden:** [Hardell and Nilsson \(2024\)](#) summarized several case reports describing microwave syndrome symptoms in people exposed to 5G antennas.
- **Brazil:** [Rodrigues et al. \(2021\)](#) reported higher cancer mortality, particularly from lung and breast cancer, in relation to exposure from mobile phone base stations.
- **Spain:** [López et al. \(2021\)](#) associated higher RF exposure with increased headaches, dizziness, and reduced sleep.
- **Italy:** [Brizzi and Marinelli](#) examined a community exposed to radar and reported increased cancer and heart disease among exposed residents.
- **Saudi Arabia:** [Meo et al.](#) linked exposure from base stations near schools with poorer motor and attention performance among adolescents.
- **India:** [Zothanslama et al. \(2017\)](#) reported blood-cell changes among residents living near mobile phone base stations.
- **India:** [Pachau and Pachau \(2016\)](#) found a strong correlation between higher tower radiation levels and health complaints, with significant symptoms reported above 2.145 mW/m<sup>2</sup>.
- **India:** [Singh et al. \(2016\)](#) found significantly more reported health problems—including sleep disturbances, headaches, and concentration difficulties—and reduced salivary secretion among people living closer to antennas.
- **Saudi Arabia:** [Meo et al. \(2015\)](#) reported an association between higher RF exposure and indicators of increased type 2 diabetes risk.
- **India:** [Gandhi et al. \(2014\)](#) found significantly elevated DNA damage among residents living within 300 meters of a mobile phone base station, particularly among women. Power density and proximity were identified as important predictors.
- **Spain:** [Gómez-Perretta et al. \(2013\)](#) reanalyzed data from [Navarro et al. \(2003\)](#). They found associations between base-station exposure and fatigue, irritability, sleep disturbances, and poor concentration, independent of demographic characteristics, other EMF sources, or radiation-related anxiety.
- **Taiwan:** [Li et al. \(2012\)](#) found that children living in areas with higher-than-median RF exposure had a significantly increased risk of neoplasms, including benign and malignant growths.

- **Egypt:** [Eskander et al. \(2012\)](#) associated six years of cell tower exposure with endocrine changes, including decreased ACTH, cortisol, and thyroid hormones, as well as decreased prolactin in females and testosterone in males.
- **Brazil:** [Dode et al. \(2011\)](#) reported elevated cancer mortality within 500 meters of mobile phone base stations.
- **Review by Australian researcher Khurana and colleagues:** [This review](#) found that eight of ten studies reported adverse symptoms or outcomes among people living within 500 meters of cell towers and wireless infrastructure.
- **Germany:** [Buchner \(2011\)](#) reported significant hormonal changes following installation of a mobile phone base station.
- **Ukraine:** [Yakymenko et al. \(2011\)](#) reviewed dozens of studies and reported evidence of increased cancer associated with long-term microwave exposure.
- **United States:** [Levitt and Lai \(2010\)](#) reviewed approximately 100 studies concerning cellular infrastructure and reported that about 80% showed biological effects.
- **Germany:** [Eger and Neppe \(2009\)](#) reported a statistically significant increase in cancer incidence among residents within 400 meters of a mobile phone base station five years after it became operational.
- **Egypt:** [Abdel-Rassoul et al. \(2007\)](#) found significantly higher rates of neuropsychiatric symptoms—including headaches, memory changes, and sleep disturbances—and reduced attention and memory performance among residents near mobile phone base-station antennas.
- **Israel:** [Wolf and Wolf \(2004\)](#) reported increased cancer incidence associated with living near a cell phone transmitter station.
- **Poland:** [Bortkiewicz et al. \(2004\)](#) described increased reports of sleep disturbances, headaches, depression, and circulatory problems among people living near cell towers, with symptoms related to proximity and exposure level.
- **Germany:** [Eger et al. \(2004\)](#) found that people living within 400 meters of a cellular transmitter had a significantly higher rate of newly diagnosed cancers and developed cancer, on average, eight years earlier than those living farther away.
- **France:** [Santini et al. \(2003\)](#) surveyed 530 residents and found significantly higher rates of symptoms, including nausea, sleep disturbances, and headaches, within 300 meters of cell towers.
- **Spain:** [Navarro et al. \(2003\)](#) found a significant correlation between the reported severity of “microwave sickness” symptoms and measured RF power density from a nearby cellular base station.
- **Italy:** [Michelozzi et al.](#) reported significantly increased leukemia mortality, particularly among men, within 3.5 kilometers of a high-power radio transmitter in Rome, with risk decreasing with distance.
- **Latvia:** [Kolodynski and Kolodynska \(1996\)](#) examined 609 schoolchildren and found statistically significant impairments in motor function, memory, attention, and reaction times among children living in areas directly exposed to radar emissions.

## ELF-EMF from power lines and other electrical sources

Numerous peer-reviewed studies worldwide have associated exposure to magnetic fields from high-voltage power lines and other electrical sources with an increased risk of childhood leukemia.

“This study presents the epidemiological evidence of childhood cancer risk on exposure to ELF-MFs, which implies that we can confirm the risk of childhood leukemia among pediatric cancers followed exposure to ELF-MFs, which is associated with a higher risk than what was previously known.”

—[Seomun, Lee and Park \(2021\), PLOS ONE, “Exposure to extremely low-frequency magnetic fields and childhood cancer: A systematic review and meta-analysis”](#)

- A [2022 systematic review by Brabant et al.](#), published in *Reviews on Environmental Health*, found that long-term exposure to magnetic fields above 0.4  $\mu$ T, or 4 milligauss, was associated with increased childhood leukemia risk, particularly acute lymphoblastic leukemia.
- A [2021 meta-analysis of 33 studies](#) found a significant association between ELF magnetic-field exposure and childhood leukemia, with possible dose-response effects.
- [Correa-Correa et al. \(2025\)](#) studied children in Mexico City and found that residential ELF magnetic-field exposure at 4 milligauss was associated with significantly increased central nervous system tumor risk. Prolonged tablet use was also associated with increased risk, particularly among children aged 6–10. Residential ELF magnetic-field exposure was measured over 24 hours.
- [Lowenthal et al. \(2007\)](#), published in the *Internal Medicine Journal*, found elevated risks of lymphoproliferative and myeloproliferative disorders among people who lived within 300 meters of high-voltage power lines during childhood. Reported risks were approximately threefold higher for exposure during the first 15 years of life and up to fivefold higher for exposure in early childhood.
- **Brain tumors:** A [2020 study](#), published in *Environmental Research*, associated residential proximity to power lines with increased brain tumor risk. A [study of children whose mothers worked as sewing machine operators during pregnancy](#), an occupation involving higher EMF exposure, also reported increased childhood brain tumor risk.
- **Melanoma:** A [2022 study](#), published in *Occupational and Environmental Medicine*, associated childhood ELF-EMF exposure with adult melanoma.
- **Male breast cancer:** A [meta-analysis of 18 studies](#), published in the *Asian Pacific Journal of Cancer Prevention*, found a significant association between EMF exposure and male breast cancer risk. [Grundy et al. \(2016\)](#), published in *Cancer Medicine*, found elevated risk among men exposed to 6 milligauss or more. Men exposed for 30 years or longer had nearly three times the risk of those exposed to less than 3 milligauss.
- **Breast cancer mechanisms:** ELF magnetic-field exposure may affect molecular pathways involved in [breast cancer and cancer progression](#). For example, [Di Donato et al. \(2023\)](#) exposed human breast cancer cells to a 50 Hz magnetic field for four hours and reported cellular and protein changes, along with faster cancer-cell growth.

- **Combined exposures:** [Numerous studies](#) have reported synergistic effects when EMF exposure is combined with other toxic exposures. For example, [animal studies conducted by the Ramazzini Institute](#) found that long-term ELF-EMF exposure combined with other carcinogens increased tumor incidence in rats.
- **Alzheimer's:** A large [18-year nationwide cohort study](#) of over 3.5 million people published in Environment International (2026) found increased risk of dementia and Alzheimer's mortality beginning around 0.5 mG ( milligauss), with stronger associations observed in the 1–3 mG range, an EMF range commonly found in homes close to electrical grid infrastructure like power lines and substations.
- **Funding can impact results:** David Carpenter, MD, Director of the Institute for Health and the Environment at the University at Albany, published [a review examining how funding sources affect EMF research findings](#) which found the source of funding significantly affects study findings. He concluded, "The evidence that magnetic fields increase the risk of cancer is neither inconsistent nor inconclusive. Furthermore, adults are also at risk, not just children, and there is strong evidence for cancers in addition to leukemia, particularly brain and breast cancer."
- **Kaiser Permanente studies** reported that prenatal ELF-EMF exposure was associated with [increased miscarriage risk](#) as well as [ADHD](#), [obesity](#), and [asthma](#). A [2020 systematic review concluded](#) that ELF-EMF exposure during early pregnancy is linked to higher first-trimester miscarriage risk. Numerous [animal studies report](#) reproductive impacts as well and a [2026 review](#) published in Frontiers in Physiology stated, "to sum up, the current available evidences indicate that the ELF-EMF exposure induces significant biological effects in the myometrium and the endometrium."

## Growing Scientific Evidence on Impacts to Flora and Fauna

Numerous peer-reviewed studies report adverse effects from wireless and non-ionizing EMF radiation exposure on birds, bees, and other insects. Scientists state that EMFs should be considered a contributing driver of global insect decline, acting synergistically with pesticides, habitat loss, invasive species, and climate change.

A landmark three part research review of non-ionizing EMF's impacts to flora and fauna citing more than 1,200 scientific references ([Levitt et al. 2021a](#), [Levitt et al. 2021b](#), [Levitt et al. 2021c](#)) found a broad range of impacts in all species studied:

*Numerous studies across all frequencies and taxa indicate that current low-level anthropogenic EMF can have myriad adverse and synergistic effects, including on orientation and migration, food finding, reproduction, mating, nest and den building, territorial maintenance and defense, and on vitality, longevity and survivorship itself. Effects have been observed in mammals such as bats, cervids, cetaceans, and pinnipeds among others, and on birds, insects, amphibians, reptiles, microbes and many species of flora.*

-Blake Levitt, Henry Lai and Albert Manville in [“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 (2022)

A 2025 follow-up review by the same authors, [“Flora and fauna: how nonhuman species interact with natural and man-made EMF at ecosystem levels and public policy recommendations”](#) updates the body of evidence drawing on newer insect exposure data, ecological measurements documenting how “today’s exposures are capable, even at very low intensities, of disrupting critical fauna/flora functions.” They caution that exposure regulations written exclusively for humans “completely miss the point of nonhuman species’ unique physiologies and extreme sensitivities.”

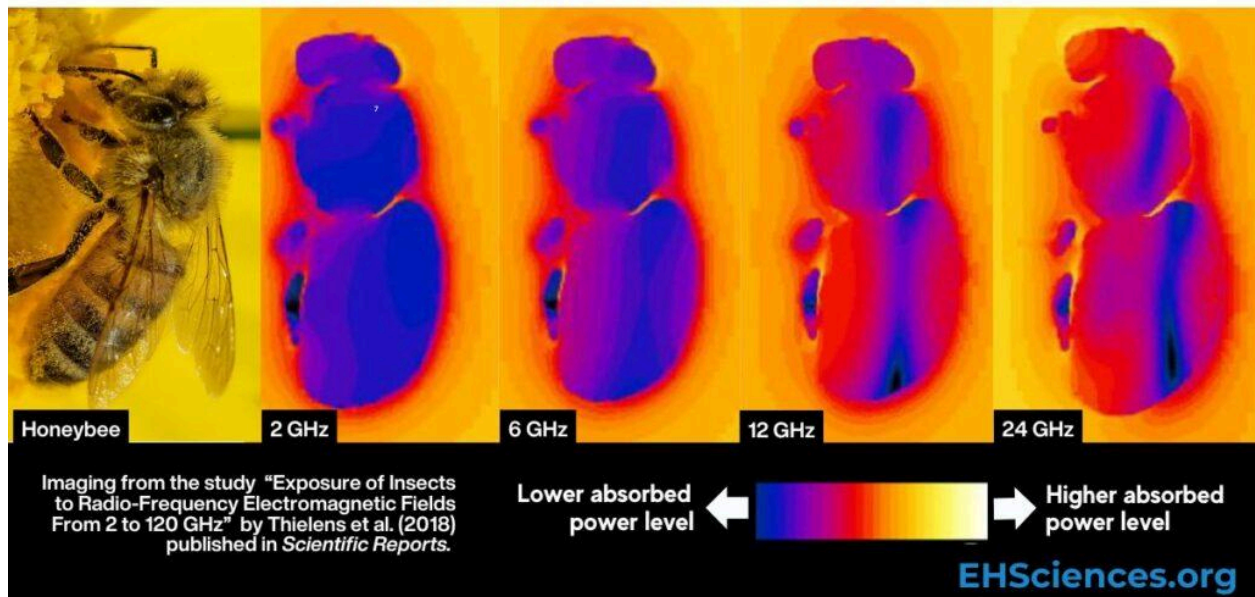
### **Insect Pollinators are Uniquely Vulnerable**

Insect pollinators are uniquely vulnerable to wireless radiation because higher-frequency signals—now rapidly expanding with 5G—are absorbed by insects at much higher levels than signals used in earlier technologies. Studies show that insects, including honey bees, absorb significantly more radiation from 5G frequencies than from 2G and 3G, as the shorter wavelengths more closely match insects’ body size, creating a resonance effect that increases energy absorption.

Even when cell antenna power levels remain the same, shifting to higher frequencies dramatically increases the amount of radiation absorbed by insects—particularly in the brain and other vital organs.

In the [first study](#) to examine this, researchers modeled four species—the Australian stingless bee, western honey bee, beetle, and locust—and found a consistent pattern: as frequencies increased toward each insect’s resonant range, absorbed power rose sharply. The researchers [concluded](#) this “could lead to changes in insect behavior, physiology, and morphology over time.”

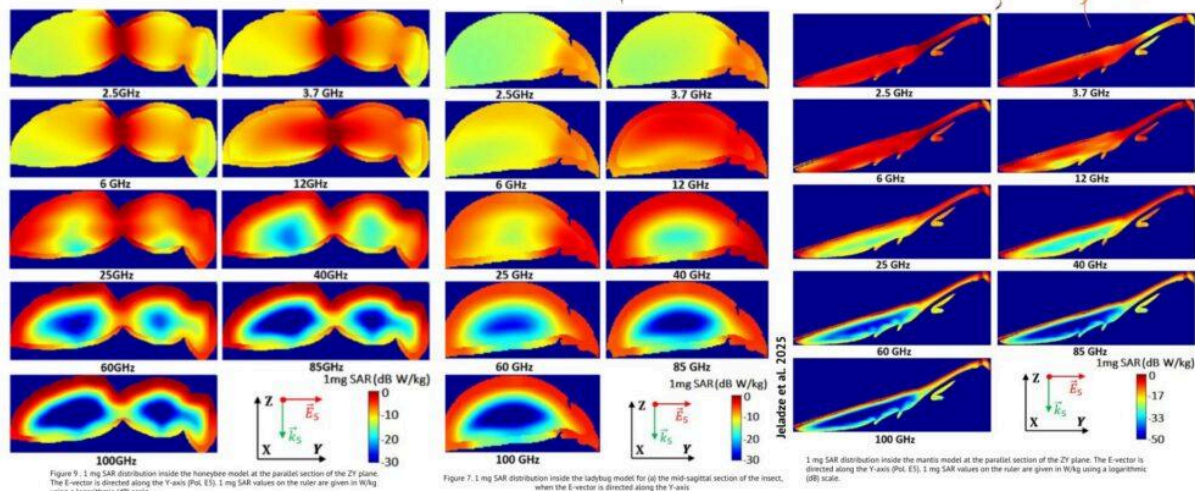
## 5G CAN INCREASE INSECT EXPOSURE



Follow-up [scientific modeling](#) of honey bees across their full life cycle, combined with real-world exposure data near beehives, found that shifting just 10% of environmental radiation to frequencies above 3 GHz—commonly used in 5G—could increase absorbed power by 390% to 570%. More [recent studies](#) have found significant increases in energy absorption in bee brains and vital organs at specific high frequencies used in modern technologies. A [2025 study](#) published in the [International Journal of Radiation Biology](#) examined how 5G and next-generation wireless radiofrequency (RF) radiation frequencies are absorbed into 4 different insects – the honeybee, wasp, ladybug, and praying mantis, and found sharp increases depending on several variables, including the waves' frequency and polarization, and the insect's size, structure, and morphology.

## 5G Radiation Frequencies (2.5 to 100 GHz) Absorbed into Honeybee, Ladybug and Praying Mantis

Study by Jeladze et al (2025)  
Finds Rates Vary in Brain and Body Tissues



Images are from "Numerical dosimetry of specific absorption rate of insects exposed to far-field radiofrequency electromagnetic fields" published in the *International Journal of Radiation Biology* by Jeladze V, Nozadze T, Partsvania B, Thielens A, Shoshiashvili L, Gogoladze T.

Maximal RF absorption into the insects' brain and inner tissues was found at 6, 12, and 25 GHz, except the brain tissue of a ladybug (max at 60 GHz) due to its smaller head. However, absorption into insects' cuticles (their hard outside covering) increased with frequency; for instance, the ladybug cuticle's rate rose from 0.1 W/kg at 2.5 GHz to 11.9 W/kg at 100 GHz – 119 times higher. Yet, the wireless revolution is increasing environmental wireless exposures at an unprecedented scale without regard for animal impacts.

## EMFs Are Considered Drivers of Colony Collapse Disorder and Insect Decline

Biologists are warning that this exposure is likely a key contributor to colony collapse in bee populations. A review by wildlife biologist Alfonso Balmori published in *Science of the Total Environment* entitled "[Electromagnetic radiation as an emerging driver factor for the decline of insects](#)" found "sufficient evidence" that electromagnetic radiation impacts insects and concludes that "electromagnetic radiation should be considered seriously as a complementary driver for the dramatic decline in insects, acting in synergy with agricultural intensification, pesticides, invasive species and climate change."

Some of the harmful impacts to bees from power-frequency and wireless EMF sources referenced by Balmori included:

- Loss of queen cells
- Changes to weight gain of hive
- Poor survival in winter
- Changes to flight, foraging, and feeding
- Impacts to short-term memory

- Induction of worker piping signals which can mean disturbance or preparation for swarming
- Reduced egg-laying speed of queen
- Decline in honey production
- Decreased honeycomb weight
- Increased mortality

A [field study](#) published in *Insects* found that combined exposure to pesticides and non-ionizing EMFs significantly worsened bee health, increasing disease prevalence, mortality, behavioral abnormalities, and biochemical disruptions. Under these multi-stress conditions, three of four colonies collapsed, supporting a causal role in hive depopulation and colony collapse disorder (CCD).

A 2023 [systematic review and meta-analysis on insects and EMFs](#) published in *Reviews on Environmental Health* reported that the vast majority of studies identified harmful biological effects of non-ionizing EMFs on insects, often at exposure levels below those currently considered safe for humans. Documented effects include disrupted navigation, reduced reproduction and fertility, altered flight dynamics, immune dysfunction, mitochondrial damage, and DNA strand breaks.

*Based on an assessment of the overall study situation on insects, we must warn against a careless deployment of further mobile telephony infrastructure, as harmful effects on insect populations would be likely, especially if interactions with other noxious agents are taken into account (including high-voltage power lines and artificial lighting). This might lead to further declines of already dwindling populations of pollinators, and would thereby entail costs for humanity.*

-Alain Thill, Marie-Claire Cammaerts and Alfonso Balmori in [“Biological effects of electromagnetic fields on insects: a systematic review and meta-analysis.”](#) *Reviews on Environmental Health* (2023)

### **Powerline EMF Impacts to Bees**

Research has documented that the EMFs generated by high-voltage transmission lines can negatively affect pollinators, particularly honeybees, by interfering with navigation, foraging, learning, stress physiology, and pollination efficiency. Because honeybees rely on highly sensitive electrical, magnetic, and sensory cues to locate flowers and communicate within colonies, researchers have raised concerns that chronic exposure to power line-associated EMFs and electric fields could contribute to pollinator decline.

A study published in *Science Advances* by [Molina-Montenegro et al. \(2023\)](#) on honeybees and EMFs from high-voltage transmission towers found that the EMF exposure increased stress-related gene expression, reduced honeybee flower visitation, impaired pollination efficiency, and even decreased seed production and plant community richness near the power lines.

A study published in iScience by [Mallinson et al. \(2025\)](#) found that electric fields at levels well below those generated by high-voltage power line transmission lines significantly alter honeybee foraging behaviors, reducing honeybee floral landings by up to 71%, while negative DC fields had no significant effect.

A series of studies by researchers at Wroclaw University Poland exposed bees to various EMF intensities reporting a range of impacts. [Migdal et al \(2020\)](#) published in Insects found the electric field exposure impacted the antioxidant system of the honeybee. [Migdal P et al. \(2021\)](#) published in Animals found behavioral disturbances may reduce the efficiency of bees as pollinators, which will translate into a decrease in the efficiency of crop production. [Migdal et al \(2021\)](#) published in PLOS ONE found the impairment of crucial metabolic cycles and alterations to the concentration of important non-enzymatic antioxidants which may indicate a disturbance in protein metabolism and increased muscle activity.

A study published in PLOS ONE by [Shepherd et al. \(2019\)](#) found that short-term in honeybees exposure to powerline EMFs, at levels that could be encountered in bee hives placed under or near power lines, impacted learning and increased aggression levels.

A study published in Scientific Reports by [Shepherd et al. \(2018\)](#) investigating how exposure to ELF EMFs below and near powerline conductors, affects honey bee olfactory learning, flight, foraging activity and feeding found that ELF-EMF exposure significantly reduced bees' cognitive performance and impaired motor abilities.

### **EMFs May Increase the Harmful Effects of Pesticides and Other Environmental Stressors in Bees**

A study by [Lupi et al. \(2021\)](#) published in Insects monitored honeybee colonies in several experimental conditions for one year and found that combined multi-stress exposure of pesticides plus electromagnetic fields from a high-voltage transmission line caused the most severe biochemical, physiological, and behavioral alterations.

“In this study, the cumulative effect of chemical and electromagnetic field exposure (multi-stress conditions) showed the worst general health condition, considering colony survival, pathology emergence and behavioural anomalies such as abnormal honey storage and excess of drone brood deposition. For the number of queen changes and the queen mortality in the underbasket, double the rate occurred than in the control and even in the chemical-stress site.” – [Combined Effects of Pesticides and Electromagnetic-Fields on Honeybees: Multi-Stress Exposure](#)

A study published in Environmental Research by [Piechowicz et al. \(2020\)](#) found that exposure to EMFs changed how honey bees broke down and detoxified two pesticides and caused changes to proteins, DNA, RNA, and other important molecules in their bodies.

### **Scientific Research Reports Harm to Plants and Trees**

Multiple reviews examining wireless radiation's impacts to plants report biological effects, with sensitivity varying by species and frequency ([Halgamuge 2017](#); [Kaur 2021](#); [Panda 2024](#)).

Documented impacts include altered growth and development, thinner cell walls, changes in gene expression, and disrupted metabolic activity.

A [nine-year field study](#) of more than 100 trees found significant, asymmetric canopy damage near cell tower antennas, beginning on the side of the tree most exposed to wireless radiation from nearby cell antennas. Experimental research on [aspen seedlings](#) similarly found reduced leaf and shoot growth and biochemical changes following wireless radiation exposure, while shielded seedlings showed no effects.

### **Here is a selection of scientific research HHS should consider.**

Scarato, T. (2025). U.S. policy on wireless technologies and public health protection: Regulatory gaps and proposed reforms. *Frontiers in Public Health*, 13, 1677583. <https://doi.org/10.3389/fpubh.2025.1677583>

Levitt, B. B., Lai, H. C., Manville, A. M., II, & Scarato, T. (2025). Flora and fauna—How nonhuman species interact with natural and man-made EMF at ecosystem levels and public policy recommendations. *Frontiers in Public Health*, 13, 1693873. <https://doi.org/10.3389/fpubh.2025.1693873>

Melnick, R. L., Moskowitz, J. M., & International Commission on the Biological Effects of Electromagnetic Fields (ICBE-EMF). (2026). Exposure limits to radiofrequency EMF do not account for cancer risk or reproductive toxicity assessed from data in experimental animals. *Environmental Health*, 25(1), 42. <https://doi.org/10.1186/s12940-026-01288-6>

International Commission on the Biological Effects of Electromagnetic Fields (ICBE-EMF). (2026). Safeguarding children's health in the digital age: Addressing screen time, wireless radiation and extremely low-frequency non-ionizing electromagnetic field exposures. Position statement. <https://icbe-emf.org/wp-content/uploads/2026/09/ICBE-EMF-Child-Health-Cell-Phone-Cell-Tower-EMF-Position-Statement-PDF-982026-1.pdf>

### **Scientific Documentation That Limits Are Inadequate**

Melnick, R. L., Moskowitz, J. M., & International Commission on the Biological Effects of Electromagnetic Fields (ICBE-EMF). (2026). Exposure limits to radiofrequency EMF do not account for cancer risk or reproductive toxicity assessed from data in experimental animals. *Environmental Health*, 25(1), 42. <https://doi.org/10.1186/s12940-026-01288-6>

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*, 21(1), 92. <https://doi.org/10.1186/s12940-022-00900-9>

- Lai, H., & Levitt, B. B. (2024). Cellular and molecular effects of non-ionizing electromagnetic fields. *Reviews on Environmental Health*, 39(3), 519–529.  
<https://doi.org/10.1515/reveh-2023-0023>
- Lai, H., & Levitt, B. B. (2022). The roles of intensity, exposure duration, and modulation on the biological effects of radiofrequency radiation and exposure guidelines. *Electromagnetic Biology and Medicine*, 41(2), 230–255.  
<https://doi.org/10.1080/15368378.2022.2065683>
- Lai, H. (2021). Genetic effects of non-ionizing electromagnetic fields. *Electromagnetic Biology and Medicine*, 40(2), 264–273. <https://doi.org/10.1080/15368378.2021.1881866>
- Lai, H., & Levitt, B. B. (2025). Radiofrequency radiation-induced gene expression. *Reviews on Environmental Health*. Advance online publication.  
<https://doi.org/10.1515/reveh-2025-0104>
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