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June 5, 2008

Connecticut Siting Council
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RE: Docket #360

<u>Hearing Exhibits Submitted by Intervenor Dina K. Jaeger - CSC Docket #360</u>

Submitted herewith pursuant to the Council's Hearing Notice of May 30, 2008 are Intervenor Jaeger's submission of Hearing Exhibits.

Respectfully submitted,

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June 5, 2008

Connecticut Siting Council
Docket No. 360

INTERVENOR JAEGER'S HEARING EXHIBITS

The following is a list of the exhibits Intervenor Jaeger presently intends to present at the public hearing on Docket No. 360.

I. Exhibits Relating to Migratory Birds and Endangered Species

IJ 1	SUNY Study on Avian Brain Neurons, 2002.
IJ 2	UCI Study on Migratory Birds, 2004.
IJ 3	Ditto – Full Text.
IJ 4	Balmori Study on House Sparrows, 2003.
IJ 5	Everaert and Bauwens Study on House Sparrows, 2007.
IJ 6	Balmori Study of White Storks, 2005.
IJ 7	Magras Study of Infertility in Mice, 1997.
IJ 8	CGS Chapter 495, Endangered Species.
IJ 9	DEP NDDB Map of Canaan, Connecticut, June, 2006.
IJ 10	DEP NDDB Map Legend.
IJ 11	Detail of NDDB Map Marked to Show Location of Proposed Tower.
IJ 12	Nature Conservancy Northwest Highlands Information Sheet.
IJ 13	DEP Instructions for NDDB Review Request.
IJ 14	DEP List of Endangered Species, Litchfield County, May, 2006.
IJ 15	DEP NDDB Letter of September 25, 2006.

I. Exhibits Relating to Migratory Birds and Endangered Species (continued)

IJ 16	McNeely Report on Migratory and Nesting Birds within 2 Miles of Beebe Hill Cell Tower site, 9/06.
IJ 17	Excerpts From DEP Atlas of Breeding Birds of Connecticut, 1994.
IJ 18	DEP American Bittern Information Sheet, 12/99.
IJ 19	DEP Pied-Billed Grebe Information Sheet, 1/00.
IJ 20	DEP Barn Owl Information Sheet, 1/00.
IJ 21	Alaska Department of Fish and Game Burbot Information Sheet, 1994.
IJ 22	DEP Connecticut Wildlife article on Mud Puppies, 3-4/06 (p.7).
IJ 23	DEP Bog Turtle Information Sheet, 12/99.
IJ 24	Wisconsin Department of Natural Resources Wood Turtle Information Sheet, 2004.
IJ 25	DEP Map 3 of Robbins Swamp WMA, 10/01.
IJ 26	Balmori Study on Amphibians, 2005.
IJ 27	New Jersey Blue-Spotted Salamander Information Sheet.
IJ 28	DEP Threatened Northern Spring Salamander Information Sheet.
IJ 29	DEP Map 5 of Housatonic State Forest.
IJ 30	UCONN Report on "Most Significant Ecological Community in the State of Connecticut."
IJ 31	Ditto – Full Text.
IJ 32	Montana State U. Columbine Duskywing Information Sheet.
IJ 33	Montana State U. Northern Metalmark Information Sheet.

II. Exhibits Relating to Property Rights and Public Safety

IJ 34	Austrian Study of Possible Health Effects Caused by Cell Tower Emissions, 2006.
IJ 35	French Study of Possible Health Effects Caused by Cell Tower Emissions, 2003.
IJ 36	German Study of Possible Health Effects Caused by Cell Tower Emissions, 2005.
IJ 37	Netherlands Study of Possible Health Effects Caused by Cell Tower Emissions, 2003.
IJ 38	Spanish Study of Possible Health Effects Caused by Cell Tower Emissions, 2003.
IJ 39	Swedish Study of Increase of Malignant Melanomas, 2004.
IJ 40	United Kingdom Department of Health Information Folders on Mobile Phones and Base Stations, 2000.
IJ 41	International Association of Firefighters Resolution urging Study of Health Effects of Cell Towers, 2004.
IJ 42	Studies of Biological Effects at Low Intensities (Compiled by Henri Lai, Bioelectromagnetics Research Laboratory, U. of Washington), 2005.
IJ 43	International Commission for Electromagnetic Safety Benevento Resolution, 2006.
IJ 44	London Times Article on Cancer Clusters at Phone Masts, 4/22/07.
IJ 45	The BioInitiative Report, Section 1
IJ 46	The BioInitiative Report, Section 17

EXHIBIT
IJ 1

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Neuroscience Letters 333 (2002) 175–178

Neuroscience Letters

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Responses of neurons to an amplitude modulated microwave stimulus

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Received 30 April 2002; received in revised form 6 August 2002; accepted 7 August 2002

Abstract

In this study we investigated the effects of a pulsed radio frequency signal similar to the signal produced by global system for mobile communication telephones (900 MHz carrier, modulated at 217 Hz) on neurons of the avian brain. We found that such stimulation resulted in changes in the amount of neural activity by more than half of the brain cells. Most (76%) of the responding cells increased their rates of firing by an average 3.5-fold. The other responding cells exhibited a decrease in their rates of spontaneous activity Such responses indicate potential effects on humans using hand-held cellular phones.
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Keywords: Cellular telephone; Magnetic field; Health risk; Avian; Central nervous system

The postulated biological effects of electromagnetic fields are highly diverse, ranging from use of natural fields by animals for navigation to thermal cooking that occurs with strong fields such as those produced by microwave ovens [7]. It has been shown that even the weak fluctuations of Earth-strength magnetic fields influence the electrical activity of neurons and pineal cells and the synthesis of melatonin in birds and mammals [1,9,10], including humans [6]. Athermal effects have been the most difficult to explain because the mechanism by which they affect biological tissue is usually unknown. The question arises as to whether there is a particular sensitivity of the neural tissues of the brain to high frequency electromagnetic fields such as is produced by broadcast transmitters.

We tested the effects of electromagnetic radio frequency (RF) signals having a carrier frequency of 900 MHz, unmodulated and pulse modulated at 217 Hz with a duty cycle of 12.5% and a peak power density of 0.1 mW/cm^2. This stimulus was selected because it is similar to that used by the global system for mobile communication (GSM) telephone system. The calculated average specific absorption rate (SAR) of this stimulus for the test subjects was 0.05 W/Kg, based on the equations in Durney and coworkers [8]. The test subjects were 34 adult zebra finches (*Taenopygia guttata*), anesthetized with a mixture of ketamine (0.05 mg/g) and xylazine (0.01 mg/g) injected i.m. into the pectoralis major. The anesthetized bird was mounted in a nonconducting plastic holder. The bird and the holder were placed inside a tuned RF cavity (23.5 cm diameter, 100.5 cm long) made of perforated metal. We used a resonate cavity (length $= 3\lambda$) because the resulting electrical field was a standing wave and, therefore, was uniformly distributed within the cavity and was measured accurately at the demodulating stub. The resonant cavity was fitted with two tuned RF stubs (each 16.5 cm [$\lambda/2$] from opposite ends): one for emitting the signal and one for monitoring the frequency and power of the signal within the cavity. This arrangement resulted in the two stubs being 2λ from each other causing the signal at the demodulation stub to be synchronized in phase and intensity to the emitted signal. The entire bird was within the cavity and positioned such that the bird's head was at the center of the cavity. This position put the bird's head exactly 1λ from the emitting stub and the demodulating stub. Consequently, the signal the bird's head received was exactly the signal at both of those locations. To record from neurons in the brain of the bird, a small hole (4 mm diameter) was made through the skull. A glass microelectrode (tip diameter 1–2 μm) filled with a conducting solution

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PII: S0304-3940(02)00903-5

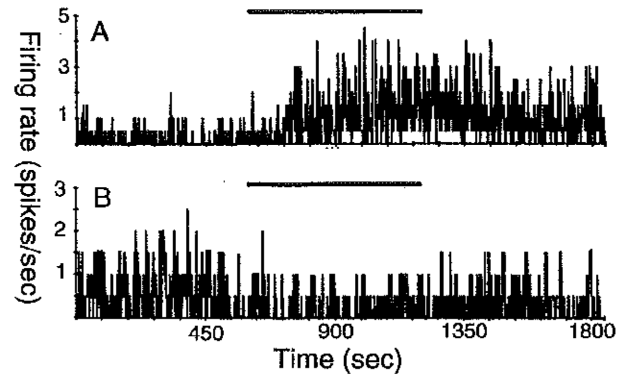

Fig. 1. Examples of neuronal responses in the zebra finch brain to stimulation of a 217 Hz, 12.5% duty cycle square wave modulated 900 MHz carrier signal: (A) simulation and (B) inhibition. The solid bar above each graph indicates the presence of the stimulating RF signal.

of physiological saline, to reduce conductivity, was slowly advanced into the brain through this hole until a spontaneously active nerve cell was detected. A silver reference electrode was inserted beneath the skin along the back of the head directly behind the glass microelectrode to complete the circuit. Arranging the electrodes along the long axis of the cavity prevented them from acting as a loop antenna and electrically stimulating the cells. Once a spontaneously active cell was located, it was tested with the stimulus. The protocol for all the testing procedures was a 10 min prestimulus period, a 10 min stimulus period, and a 10 min poststimulus period. The rates of the cell's activity during these three time intervals were compared to detect any effect of the stimulation. A responding cell was one that changed its firing rate during the stimulation by at least 10%.

The microwave stimulus signal was produced by an Amplifier Research amplifier (model 10W1000M7) driven by an HP 8350A sweep oscillator with an HP 83522A RF unit set for 900 MHz. Amplitude modulation of the signal was produced by a free running HP 3314A function generator set for 217 Hz square wave signal with a duty cycle of 12.5%. The output of the amplifier was switched between a matched load and the cable to the waveguide chamber by a single-pole, double-throw RF switch (HP 8761A). The switch was controlled by a digital signal from the computer program TIDA on an IBM-compatible microcomputer. The frequency and intensity of the emitted signal were monitored using an HP 5342A microwave frequency counter connected to the demodulator stub in the waveguide cavity. All power measurements were of peak power.

We recorded 133 spontaneously active units from 34 anesthetized adult zebra finches. The recording locations were in the cerebrum (Pars occipitalis and Pars parietalis) and Folia of the anterior cerebellum. Ninety-one units (69%) showed some response to the stimulation: 69 (52%) responded with excitation (Fig. 1A) and 22 (17%) responded with inhibition (Fig. 1B). The remaining 42 (31%) cells showed no discernible response. The cells showing excitation responded with increases in their rate of firing to the stimulation (mean rate during stimulation = 3.5 ± 0.30 [SE] times prestimulus rate; Fig. 2). Most of the inhibitory responses were small (mean rate during stimulation = 0.4 ± 0.07 times prestimulus rate; Fig. 2), in part because the cells were firing slowly before the stimulation. There was a significant difference among the firing rates of the three responses and the prestimulus firing rate (Kruskal–Wallis test: $H_c = 216.8$, $P < 0.001$, $v = 5$; see Fig. 3). Based on a non-parametric multiple comparison [13], the firing rates in the three response categories different from one another significantly ($P < 0.05$; Q = 3.817–4.341). There was no significant difference among the firing rates of the nonresponding cells during the prestimulus, stimulus, and post-stimulus periods ($P > 0.05$). All responses we recorded were to power densities of 0.1 mW/cm^2 (SAR = 0.05 W/Kg) and stronger (up to 0.5 mW/cm^2). The mean latency from the initiation of the stimulus to the start of the response was 104 ± 197 s, with the response lasting beyond the end of the stimulus period in half of the responding cells. The mean persistence beyond the end of stimulation was 308 ± 68 s, but there was no correlation ($r = 0.489$, $P > 0.05$) between the latency of the response and how long the cell continued responding beyond the end of the stimulus.

Three cells that responded to the modulated carrier were also tested with an unmodulated signal of the same carrier frequency. The power of the unmodulated signal was tested at two densities: one that equaled the peak power of the modulated stimulus and one that equaled the average power of the modulated stimulus. None of these cells exhibited a response to the unmodulated carrier. In addition to responses to the nominal stimulus, we also tested four cells that did not respond to the 0.1 mW/cm^2 pulsed signal with higher power densities

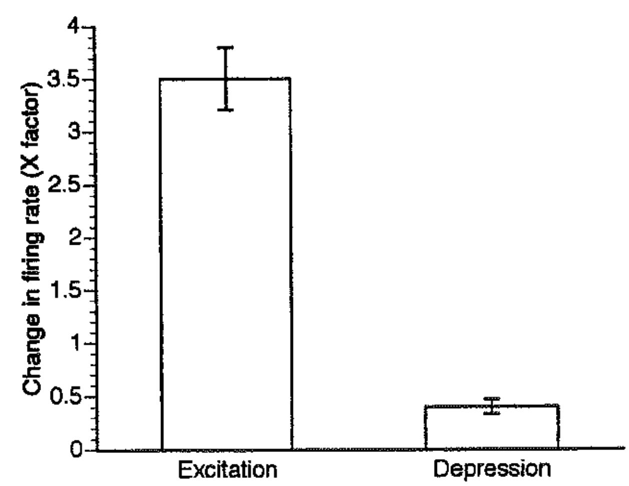

Fig. 2. Mean relative firing rates of cells that responded to the simulated GSM signal and were categorized as excitation or depression. The firing rates are relative to the cells' firing rates during the prestimulus period. The vertical bars indicate 1 standard error.

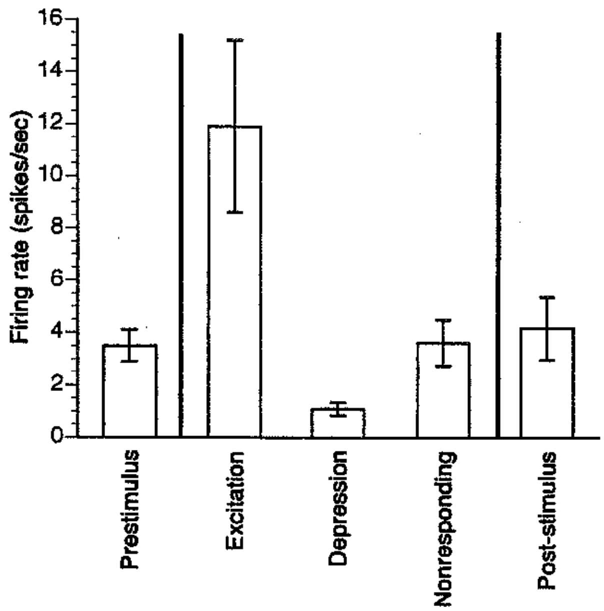

Fig. 3. Firing rates of zebra finch neurons during the prestimulus (10 min), stimulus (10 min), and poststimulus (10 min) periods. The poststimulus values are for the non-responding cells only because the responding cells often continued their response into the post-stimulus period (see text for details). The firing rates of the three responses differed significantly (Kruskal–Wallis test: $H_c = 216.8$, $P < 0.001$, $v = 5$). The vertical bars indicate 1 standard error.

(up to 0.5 mW/cm^2). Three cells did not respond to the stronger intensities, but one cell that did not respond to the 0.1 mW/cm^2 stimulus responded to an intensity of 0.3 mW/cm^2 with depression of its rate of activity.

One concern was that the electrodes themselves were acting as an antenna and stimulating the cells electrically. The arrangement of the active and reference electrode centered along the long axis of the waveguide chamber prevented them from serving as a loop antenna. In preliminary experiments we varied the positions of the electrodes to determine whether they could, in fact, act as an antenna. When the electrodes were not aligned longitudinally, the stimulus artifact was detected directly and observed on the oscilloscope display. Whether such a stimulus was strong enough to stimulate the cells is unknown. A second factor that supports the idea that the cells were not stimulated electrically is that not all cells responded to the stimulus, even those in the close neighborhood of a responding cell. This clearly speaks against an artifact.

These high frequency RF fields produced a response in many types of neurons in the avian central nervous system (in both cerebellum and cerebrum) and did not appear to be limited to any specialized receptor. Similar responses (long latency and ongoing higher activity after cessation of the stimulus) also were recorded to a 52 GHz carrier, 16 Hz modulated signal (Semm et al., unpubl. data). Thus, the effect does not appear to be limited to magnetic sensory cells [11], but may occur in any part of the brain. The similar responses to different frequencies point toward a common mechanism of low frequency modulation, perhaps at the cell membrane. Such a stimulus might mimic a natural mechanism involved in cell communication, producing responses from many different types of neurons. It is unlikely that the effects we observed are the result of thermal excitation caused by the RF radiation because the power densities we applied were 2–3 orders of magnitude below what is required (10 mW/cm^2) to produce heating of even 0.5 °C [2]. It is also unlikely that localized areas of the brain were heated and thermally stimulated because neurons responded only to the modulated signal and did not respond to unmodulated signals that were the same strength. Consequently, we conclude that the effects we observed are not the result of thermal agitation but at this point we cannot offer an athermal mechanism to account for the observations.

Although individual neurons in the zebra finch brain responded to the pulsed RF stimulus, we do not know whether these responses by the nervous system are manifested in the bird's behavior or its health. Bruderer and coworkers [4,5] reported no behavioral responses of birds to pulsed or continuous RF microwave signals, but their studies involved different frequencies and lower power densities of the stimulus. Thuróczy and coworkers reported neuronal responses of freely moving rats [12] similar to the responses we observed in the zebra finch. During the period of stimulation, sensitive cortical neurons of Long Evans rats showed either an increase or a decrease in the rate of spontaneous activity. The changes in firing rates were less than the changes we observed in the zebra finch: an increase of less than 2× in the rat versus 3.5× in the finch and a decrease to 0.67× in the rat versus 0.4× in the finch. Although the neuronal responses were similar between the rat and the finch, the SAR values of the RF field used with the rat were much greater than that used for the finch. Thuróczy and coworkers also observed behavioral responses by the rat to the GSM signal. In conditioning experiments, the rats' reaction times decreased during stimulation as did their learning rate (as measured by discrimination tasks).

Whether similar neuronal responses occur in other mammals, including humans, requires further investigation. Borbély and coworkers [3] reported that exposure to a RF signal similar to the one we used influenced sleep and sleep electroencephalogram in humans. Their results and the responses we recorded clearly indicate the potential for effects on the human nervous system.

We gratefully acknowledge financial support of the Deutsche Telekom and the Geneseo Foundation. Technical assistance and the loan of equipment were provided by the Deutche Telekom. This research was conducted in the Zoology Institute of the J. W. Goethe Univ. in Frankfurt.

[1] Bartsch, H., Bartsch, C., Mecke, D. and Lippert, T.H., Seasonality of pineal melatonin production in the rat: possible synchronization by the geomagnetic field, Chronobiol. Int., 11 (1994) 21–26.

[2] Bernhardt, J.H., Non-ionizing radiation safety: radiofrequency radiation, electric and magnetic fields, Phys. Med. Biol., 37 (1992) 80–84.
[3] Borbély, A.A., Huber, R., Graf, T., Fuchs, B., Gallmann, E. and Achermann, P., Pulsed high-frequency electromagnetic field affects human sleep and sleep electroencephalogram, Neurosci. Lett., 275 (1999) 207–210.
[4] Bruder, B. and Boldt, A., Homing pigeons under radio influence, Naturewissenschaften, 81 (1994) 316–317.
[5] Bruderer, B., Peter, D. and Steuri, T., Behaviour of migrating birds exposed to X-band radar and a bright light beam, J. Exp. Biol., 202 (1999) 1015–1022.
[6] Burch, J.B., Reif, J.S. and Yost, M.G., Geomagnetic disturbances are associated with reduced nocturnal excretion of a melatonin metabolite in humans, Neurosci. Lett., 266 (1999) 209–212.
[7] Carpenter, D.O. and Ayrapetyan, S., Biological Effects of Electric and Magnetic Fields, 2 Vols., Academic, New York, 1994, p. 726.
[8] Durney, C.H., Massoudi, H. and Iskander, M.F., Radiofrequency Radiation Dosimetry Handbook, 4th Edition, USAF School of Aerospace Medicine, Brooks AFB, TX, 1985, USAFSAM-TR-85-73.
[9] Reiter, R.J., Melatonin suppression by static and extremely low frequency electromagnetic fields: relationship to the reported increased incidence of cancer, Rev. Environ. Health, 10 (1994) 171–186.
[10] Reuss, R. and Semm, P., Effects of an earth-strength magnetic field on pineal melatonin synthesis in pigeons, Naturwissenschaften, 74 (1987) 38–39.
[11] Semm, P. and Beason, R.C., Responses to small magnetic variations by the trigeminal system of the bobolink, Brain Res. Bull., 25 (1990) 735–740.
[12] Thuróczy, G., Hernádj, I. and Kellény, L., Activity and learning memory task of the rat, BEMS Abstract, (2001) 27.
[13] Zar, J.H., Biostatistical Analysis, 4th Edition, Prentice Hall, Upper Saddle River, NJ, 1999, p. 941.

EXHIBIT
IJ 2
Blumberg No. 5136

Chemical reaction in birds provides sense of direction during migratory flights

Study could help identify mechanism of magnetoreception in animals and humans

Irvine, Calif. , May 12, 2004

Migrating birds stay on track because of chemical reactions in their bodies that are influenced by the Earth's magnetic field, a UC Irvine-led team of researchers has found.

The birds are sensitive even to rapidly fluctuating artificial magnetic fields. These fields had no effect on magnetic materials such as magnetite, indicating that the birds do not rely on simple chunks of magnetic material in their beaks or brains to determine direction, as experts had previously suggested.

The results are reported in the May 13 issue of *Nature*. The study is the first to reveal the mechanism underlying magnetoreception – the ability to detect fluctuations in magnetic fields – in migratory birds.

In the study, Thorsten Ritz, assistant professor of physics and astronomy, and colleagues exposed 12 European robins to artificial, oscillating magnetic fields and monitored the orientation chosen by these birds. The stimuli were specially designed to allow for responses that could differ depending on whether birds used small magnetic particles on their bodies or a magnetically sensitive photochemical reaction to detect the magnetic field.

"We found that the birds faced in the usual direction for their migration when the artificial field was parallel to the Earth's natural magnetic field, but were confused when the artificial field was applied in a different direction," said Ritz, the lead author of the paper. "Since the artificial field's oscillations were too rapid to influence magnetic materials like magnetite, it suggests that the most likely mechanism for magnetic orientation in these birds involves tiny changes to magnetically sensitive chemical reactions, possibly occurring in the eyes of the birds – we are not sure."

In the experiments, the robins could walk and flutter in

European robin

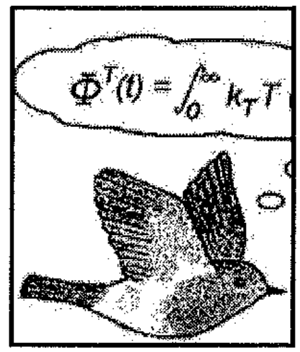

Photo credit: Thorsten Ritz

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their cages but could not fly. The birds oriented well in the Earth's magnetic field alone, but were disoriented in the presence of a broad-band (0.1-10 megahertz) and 7 megahertz oscillating field, aligned at a 24 or 48 degree angle to the Earth's magnetic field. When the same 7 megahertz oscillating field was aligned parallel to the Earth's magnetic field, the robins showed normal migratory orientation again.

"Unlike our senses involving vision, hearing, smell and touch, we do not know what receptors underlie magnetoreception," Ritz said. "Migratory birds have long been known to possess a magnetic compass that helps them find the correct direction during their migratory flights. It has remained unknown, however, how birds can detect the direction of the Earth's magnetic field.

"Now, our study points to what we need to look for a molecular substrate for certain chemical reactions. That is, we can rule out magnetic materials in birds' beaks and elsewhere as being possible candidates. Magnetite in the beaks, however, may play a role in detecting the strength but not the direction of the Earth's magnetic field."

The experiments on the birds were conducted in a six-week period in 2003 in Frankfurt, Germany, in the laboratory of Wolfgang and Roswitha Wiltschko, co-authors of the paper, who developed the behavioral experimental setup used in the study for testing magnetic orientation in birds. During migratory unrest, the birds could move in their cages. Each cage was funnel-shaped, lined with coated paper and measured approximately 1.5 feet in diameter. When the birds moved in the cages, they left scratch marks that were counted subsequently by the researchers and analyzed.

To produce artificial oscillating fields, the researchers fed high-frequency currents from a signal generator into a coil that surrounded four test cages. The coil, with a diameter of approximately two meters, could be moved to change the alignment of the oscillating field. Each bird was tested once a day during dusk for a period of approximately 75 minutes.

Besides the Wiltschkos of J. W. Goethe-Universität, Germany, Ritz was joined in the study by John B. Phillips of Virginia Tech and Peter Thalau of J. W. Goethe-Universität.

The research was funded by the Deutsche Forschungsgemeinschaft and the Fetzer Institute.

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Blumberg No. 5136
EXHIBIT
IJ3

Resonance effects indicate a radical-pair mechanism for avian magnetic compass

Thorsten Ritz[1], Peter Thalau[2], John B. Phillips[3], Roswitha Wiltschko[2] & Wolfgang Wiltschko[2]

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Migratory birds are known to use the geomagnetic field as a source of compass information[1,2]. There are two competing hypotheses for the primary process underlying the avian magnetic compass, one involving magnetite[3–5], the other a magnetically sensitive chemical reaction[6–8]. Here we show that oscillating magnetic fields disrupt the magnetic orientation behaviour of migratory birds. Robins were disoriented when exposed to a vertically aligned broadband (0.1–10 MHz) or a single-frequency (7-MHz) field in addition to the geomagnetic field. Moreover, in the 7-MHz oscillating field, this effect depended on the angle between the oscillating and the geomagnetic fields. The birds exhibited seasonally appropriate migratory orientation when the oscillating field was parallel to the geomagnetic field, but were disoriented when it was presented at a 24° or 48° angle. These results are consistent with a resonance effect on singlet–triplet transitions and suggest a magnetic compass based on a radical-pair mechanism[7,8].

The magnetic compass of birds is light-dependent[9,10], and exhibits strong lateralization with input coming primarily from the right eye[11]. However, the primary biophysical process underlying this compass remains unexplained. Magnetite[3–5,12] as well as biochemical radical-pair reactions[7,8] have been hypothesized to mediate sensitivity to Earth-strength magnetic fields through fundamentally different physical mechanisms. In the magnetite-based mechanism, magnetic fields exert mechanical forces[3]. In the radical-pair mechanism, the magnetic field alters the dynamics of transitions between spin states, after the creation of a radical pair through a light-induced electron transfer. These transitions in turn affect reaction rates and products[7,8]. Although in most radical-pair reactions the effects of Earth-strength magnetic fields are masked by stochastic fluctuations, model calculations[13] show that such effects can be amplified beyond the level of stochastic fluctuations in specialized radical-pair receptor systems.

Exploiting the principles of magnetic resonance, we developed a diagnostic tool to identify a radical-pair process as the primary process for a physiological magnetic compass. No change in magnetic alignment of magnetite receptors is expected for weak oscillating fields with frequencies larger than 100 kHz (ref. 14).

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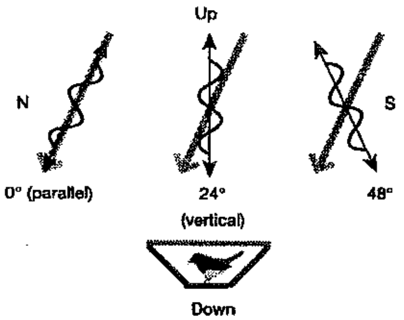

Figure 1 Experimental set-up. Orientation of the 7.0-MHz oscillating magnetic fields (black arrows with sine curve) parallel, at a 24° (vertical) and at a 48° angle to the geomagnetic field (grey arrows; see Fig. 2c–e for results). In the parallel and 48° conditions, the oscillating fields have the same angle with respect to the birds in our experimental set-up.

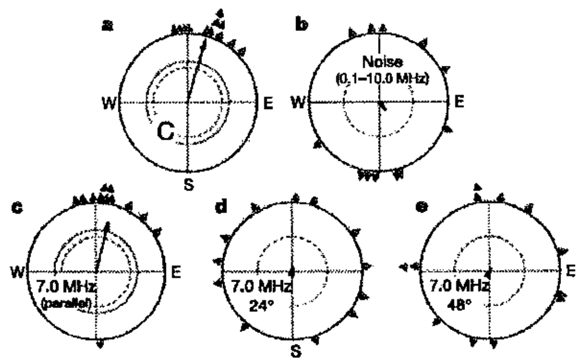

Figure 2 Effects of oscillating magnetic fields on magnetic orientation behaviour of European robins. Triangles indicate the mean headings of the 12 test birds, arrows represent the grand mean vectors (unit length = outer circle radius; see Table 1 for numerical values). The inner circles mark the 5% (dotted) and the 1% significance border of the Rayleigh test[27]. **a**, Tests in the geomagnetic field only. **b**, Tests in the geomagnetic field and a broadband (0.1–10 MHz) noise field of 0.085 μT. **c–e**, Tests in a 7.0-MHz field of 0.47 μT, oriented either parallel (**c**), at a 24° angle (**d**), or at a 48° angle (**e**) to the geomagnetic field.

However, an oscillating magnetic field that is in resonance with the splitting between radical-pair spin states can perturb a radical-pair mechanism by directly driving singlet–triplet transitions. In typical biomolecules, many hyperfine splittings occur in the range of 0.1–10 MHz and a limited number may exist in the range of 10–25 MHz (ref. 15).

We used the migratory orientation of European robins, *Erithacus rubecula*, to detect the possible effects of oscillating magnetic fields on the underlying magnetoreception mechanism. Orientation tests were performed during spring migration under 565 nm light; conditions under which robins normally show excellent orientation using their inclination compass[16,17]. All birds were tested indoors, in the local geomagnetic field of 46 μT and 66° inclination. In addition to the control condition (geomagnetic field alone, no oscillating field), we used four experimental conditions in which an oscillating magnetic field was added to the geomagnetic field (Fig. 1).

In the control condition, the robins exhibited seasonally appropriate northerly orientation (Fig. 2a), but in the presence of broadband (0.1–10 MHz, 0.085 μT) and single-frequency (7 MHz, 0.47 μT) oscillating fields, both vertically aligned (see Fig. 1), the birds were disoriented (Fig. 2b, d).

To confirm that the observed behavioural change was caused by a direct effect of the oscillating fields on the magnetic compass and not by nonspecific effects due to changes in motivation and so on, we varied the alignment of the 7.0-MHz field. The frequencies at which an oscillating field perturbs a radical-pair reaction depend not only on the chemical nature of the radical pair, but also on the alignment of the oscillating field with respect to the static field[18]. This implies that the responses of a magnetic compass system based on radical pairs in the presence of a weak, single-frequency oscillating field can depend on the alignment of the oscillating field, whereas nonspecific effects should occur independently of alignment. We tilted the oscillating field 24° to the north or 24° to the south, so that the two oscillating fields were aligned at the same angle relative to the vertical, but at different angles, parallel and 48°, relative to the geomagnetic field (Fig. 1).

When the oscillating field was parallel to the geomagnetic field, the birds oriented in the migratory direction (Fig. 2c) and their response was indistinguishable from that of the control condition (Table 1). In contrast, when the same oscillating field was presented at 24° and 48° relative to the geomagnetic field, the birds were disoriented (Fig. 2d, e) and their response differed significantly from that of the control condition ($P < 0.01$). The intra-individual scatter in the distribution of nightly headings, as reflected by the length of the birds' mean vectors (r_b), was indistinguishable from that of the control condition when the 7-MHz oscillating field was parallel to the geomagnetic field, but was significantly greater (lower r_b) in the other three oscillating-field conditions (that is, broadband and 7 MHz at 24° and 48° angles) (see Table 1).

Our findings show that it is unlikely that oscillating fields have an effect on magnetite-based receptors[3–5,12], because the dampening effects of the cellular environment prevent magnetite particles from tracking weak radio-frequency magnetic fields. Even in very-low-viscosity physiological conditions (spherical single-domain magnetite in water) we can estimate, following ref. 14, that a 7-MHz field would require an intensity of 285 μT to produce a noticeable change in alignment, which is far stronger than the 0.47 μT fields used in our experiments. Likewise, frequencies used in these experiments of less than 10 MHz are far from the expected ferromagnetic resonance frequencies in the GHz range[19], thus rendering thermal or lattice vibration effects of the oscillating fields on magnetite unlikely.

In contrast, resonance effects of oscillating magnetic fields in the frequency range of 0.1–10 MHz are expected in a radical-pair mechanism because hyperfine splittings occur in this range[15]. Resonance effects in this frequency range would also be expected in the context of Leask's optical pumping hypothesis[6], although the lack of evidence for a biological source of energy in the radio-frequency range required by the optical-pumping process[6] makes this mechanism unlikely.

By what physical mechanism could the remarkably weak oscillating fields used in our experiments (0.085 μT, 0.47 μT) affect a radical-pair reaction, and in turn, a radical-pair-based compass system? A simple model calculation (see Methods) suggests that at least in some radical-pair reactions (radical pairs with one dominant hyperfine interaction and a long lifetime), a resonant oscillating magnetic field of a thousandth of the geomagnetic field strength can produce a detectable effect. This remarkable sensitivity to very weak resonant oscillating fields is a noteworthy feature and further studies should analyse the limits of sensitivity in more realistic descriptions of radical pairs.

Our data, together with the above analysis, indicate that a magnetically sensitive radical-pair process in European robins is linked to the physiology of magnetic compass orientation. The most straightforward explanation for our findings is that the radical-pair process indicated by our experiments works as the primary process underlying magnetic compass orientation in European robins and probably in other birds[10]. Of course, we cannot exclude the possibility that a radical-pair reaction that is part of an unrelated biochemical pathway was affected. However, the fact that resonance

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Table 1 **Orientation of European robins in different oscillating magnetic field conditions**

	Geomagnetic field only		Noise (0.1–10 MHz)		7.0 MHz parallel		7.0 MHz 24°		7.0 MHz 48°	
Bird	α_b	r_b	α_b	r_b	α_b	r_b	α_b	r_b	α_b	r_b
R 1	26°	0.98	339°	0.24	358°	1.00	110°	0.53	274°	0.45
R 2	20°	0.76	183°	0.42	4°	0.95	126°	0.48	9°	0.84
R 3	47°	0.91	194°	0.61	344°	0.70	86°	0.32	226°	0.98
R 4	350°	0.72	3°	0.21	10°	0.99	17°	0.37	32°	0.20
R 5	15°	0.94	189°	0.74	12°	0.99	162°	0.37	112°	0.85
R 6	1°	0.94	37°	0.90	27°	0.80	330°	0.29	351°	0.17
R 7	18°	1.00	64°	0.42	350°	0.29	297°	0.44	193°	0.73
R 8	20°	0.99	112°	0.51	57°	0.45	220°	0.96	109°	0.11
R 9	354°	0.97	354°	0.80	177°	0.27	58°	0.89	177°	0.32
R 10	24°	0.82	166°	0.09	8°	0.99	261°	0.42	352°	0.15
R 11	358°	0.81	163°	0.84	6°	0.99	278°	0.28	75°	0.80
R 12	37°	0.79	235°	0.47	41°	0.86	3°	0.78	273°	0.31
Grand mean vector	16°, 0.96***		142°, 0.18 n.s.		14°, 0.78***		11°, 0.10 n.s.		22°, 0.07 n.s.	
Median individual vector length	0.93		0.49		0.90		0.43		0.38	
ΔC	C	C	**	***	n.s.	n.s.	**	***	**	**

The α_b and r_b values are based on three recordings of the bird under the respective condition. The grand mean vector is given with its significance by the Rayleigh test indicated by asterisks, followed by the median individual vector length. The bottom line indicates significant differences from the control data obtained in the geomagnetic field only (see Methods for tests). Significance levels: ***, $P < 0.001$; **, $P < 0.01$; n.s., not significant.

effects are only expected in specialized radical-pair systems that can also detect the geomagnetic field[7,13], makes it unlikely that a radical-pair process not associated with magnetoreception was affected. There is currently no evidence supporting the existence of such a magneto-sensitive radical-pair process outside the context of magnetoreception and even if one existed, it is uncertain whether it would affect orientation behaviour. In our study we observed no change in activity between birds in oscillating-field and control conditions; and food intake and the general appearance of the birds was normal, suggesting that their health and motivation were unaffected by the brief 75 min exposure to oscillating magnetic fields. In view of this, our findings probably reflect a direct effect of the oscillating fields on the compass mechanism.

This conclusion does not rule out the possibility that birds possess an additional magnetically sensitive system based on magnetite. Magnetite in the form of single domains and super-paramagnetic crystals embedded in specialized structures has been described in the ethmoid region and in the upper beak of migratory birds and pigeons[20,21]. However, behavioural evidence[22–24] as well as electrophysiological recordings[25,26] suggest that the magnetite discovered is not involved in magnetic compass orientation, but instead forms the basis of a magnetic-intensity sensor, potentially used in a magnetic 'map' sense for determining geographic position.

Our study establishes the use of oscillating magnetic fields as a diagnostic tool that can indicate the involvement of a magneto-sensitive radical-pair reaction in birds. Extending this tool to determine the frequency range in which oscillating fields affect the radical-pair mechanism can reveal the chemical nature of the radical pairs involved. Finally, using oscillating magnetic fields as a diagnostic tool is not specific to birds and should be easily transferable to assays with other animal groups. The threshold intensity at which oscillating-field effects can be observed provides information about the underlying mechanism. Behavioural effects from oscillating fields of similar intensity to those used in the present study would suggest a radical-pair mechanism. The absence of behavioural effects from oscillating fields of intensities greater than 50 μT would make a radical-pair mechanism unlikely. □

Methods

Test birds

European robins are small passerines that migrate at night. The test birds were mist-netted as transmigrants in early September 2002 in the Botanical Garden near the Zoological Institute in Frankfurt am Main (50° 08′ N, 8° 40′ E). The birds were kept indoors in individual cages over the winter on a photoperiod that simulated local conditions until December, but was then reduced to 8:16 h light:dark. In the beginning of January 2003, the photoperiod was increased to 13:11 h light:dark. This induced premature *Zugunruhe* (nocturnal migratory restlessness); the experiments took place between 13 January and 17 February 2003.

Test conditions

The tests took place in wooden huts in the garden of the Zoological Institute within the local geomagnetic field of 46 μT and 66° inclination. To produce the oscillating fields, we modified a test design developed by J.B.P. for similar tests (J.B.P., unpublished), consisting of a coil antenna (210 cm diameter) mounted on a rotatable wooden frame surrounding the test arena. Oscillating currents from a high frequency (HF) generator (Stanford Research Systems DS 34) were amplified by a HF amplifier (Research AF Model 25 W 1,000) and fed into the coil through a resistance of 51 Ω. The coil consisted of a single winding of coaxial cable (RG62A/U, 93 Ω) with 2 cm of the screening removed opposite the feed. The HF field was measured daily, before each test session, using a spectrum analyser (HP89410A) and a magnetic field probe (Rohde & Schwarz, HZ-11816.2770.0, 3 cm probe). Within the test arena, the inhomogeneity of the field was less than 15%. Variations in field intensities between tests were less than 20% of the average value. The HF generator and amplifier were placed outside the huts in varying positions with respect to the test arena. They were switched on during the majority of control tests, but with the power generator turned to zero; comparisons with control tests without this arrangement revealed no observable effect of this procedure.

Test apparatus and procedure

Testing followed standard procedures[16]: birds were tested individually in funnel-shaped PVC cages (35 cm upper diameter; 20 cm high) lined with coated paper (BIC Germany, formerly TippEx); the birds left scratches in the coating as they moved. The cages were covered with an opaque plexiglass cover and placed in PVC cylinders, the top of which consisted of a plastic disk carrying the same green light-emitting diodes as those used in earlier studies[9,16] (peak frequency at wavelength $\lambda = 565$ nm, with $\lambda/2$ at 533 and 583 nm, respectively). The light passed through two diffusers before reaching the bird with an intensity of 2.1 mW m^{-2}.

The birds were tested once per day. Tests began when the light went out in the housing cages and lasted about 75 min. Each bird was tested three times in each condition. The three tests were arranged in sets; the set of second and third tests began after the set of first and second tests respectively was completed. Within each set, the tests in the various conditions were performed in a pseudo-random order, with the sequence differing between birds.

Data analysis and statistics

For the data analysis, the coated paper was divided into 24 sectors, and the scratches per sector were counted by experimenters that were blind to the test condition. The heading of the respective test was determined by vector addition. From the three headings per test condition for each bird, the mean vector with heading α_b, and length r_b, was calculated. The twelve α_b values were combined to a grand mean vector, which was tested for directional significance using the Rayleigh test[27]. The distributions of the birds' α_b values in different conditions were compared using the Mardia–Watson–Wheeler test[27]. The r_b values, representing the intra-individual variance in locating the migratory direction, are not normally distributed; and so medians are given for each test condition. The r_b values were compared with those obtained under the control conditions using the Wilcoxon test for matched pairs of data.

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Model calculations

We used a one-proton radical-pair model[28] with an isotropic hyperfine coupling, a, of 0.5 mT, an anisotropy, α of 0.3, and a lifetime of 20 μs (corresponding to the observed lifetime of flavin-tryptophan radical pairs[15]). We solved the stochastic Liouville equation to determine the triplet yield in the presence of a static magnetic field of 46 μT. We then calculated, by direct numerical integration of the stochastic Liouville equation, the change in triplet yield, $\Delta\Phi_{OMF}$, caused by an additional 1.3 MHz oscillating magnetic field in resonance with the splitting due to the 46 μT static field. For comparison, we also calculated the triplet yield change, $\Delta\Phi_{static}$, resulting from a decrease of 12 μT in static field, noting that such a change led to disorientation in the magnetic compass orientation responses of robins[29]. The intensity of the oscillating field required for $\Delta\Phi_{OMF}$ to equal $\Delta\Phi_{static}$ is 0.033 μT, that is, less than any of the intensities employed in our experiments.

Received 2 September 2003; accepted 30 March 2004; doi:10.1038/nature02534.

1. Wiltschko, W. & Wiltschko, R. Magnetic compass of European robins. *Science* 176, 62–64 (1972).
2. Wiltschko, R. & Wiltschko, W. *Magnetic Orientation in Animals* (Springer, Berlin, 1995).
3. Kirschvink, J. & Gould, J. Biogenic magnetite as a basis for magnetic field detection in animals. *BioSystems* 13, 181–201 (1981).
4. Edmonds, D. T. A sensitive optically detected magnetic compass for animals. *Proc. R. Soc. Lond. B* 263, 295–298 (1996).
5. Shcherbakov, V. P. & Winklhofer, M. The osmotic magnetometer: a new model for a magnetite-based magnetoreceptor in animals. *Eur. Biophys. J.* 28, 380–392 (1999).
6. Leask, M. J. A physico-chemical mechanism for magnetic field detection by migratory birds and homing pigeons. *Nature* 267, 144–145 (1977).
7. Schulten, K. Magnetic field effects in chemistry and biology. *Festkörperprobleme (Adv. Solid State Phys.)* 22, 61–83 (1982).
8. Ritz, T., Adem, S. & Schulten, K. A photoreceptor-based model for magnetoreception in birds. *Biophys. J.* 78, 707–718 (2000).
9. Wiltschko, W., Munro, U., Ford, H. & Wiltschko, R. Red light disrupts magnetic orientation of migratory birds. *Nature* 364, 525–527 (1993).
10. Wiltschko, W. & Wiltschko, R. Magnetic compass orientation in birds and its physiological basis. *Naturwissenschaften* 89, 445–452 (2002).
11. Wiltschko, W., Traudt, J., Güntürkün, O., Prior, H. & Wiltschko, R. Lateralization of magnetic compass orientation in a migratory bird. *Nature* 419, 467–470 (2002).
12. Kobayashi, A. & Kirschvink, J. in *Electromagnetic Fields: Biological Interactions and Mechanisms* (ed. Blank, M.) 367–394 (American Chemical Society Books, Washington DC, 1995).
13. Weaver, J., Vaughn, T. & Astumian, R. Biological sensing of small differences by magnetically sensitive chemical reactions. *Nature* 405, 707–709 (2000).
14. Kirschvink, J. *et al.* in *Sensory Transduction* (eds Corey, D. & Roper, S.) 225–240 (Society of General Physiologists 45th Annu. Symp., Rockefeller Univ. Press, New York, 1992).
15. Cintolesi, F., Ritz, T., Kay, C., Timmel, C. & Hore, P. Anisotropic recombination of an immobilized photoinduced radical pair in a 50 μT magnetic field: a model avian photomagnetoreceptor. *Chem. Phys.* 294, 384–399 (2003).
16. Wiltschko, W. & Wiltschko, R. The effect of yellow and blue light on magnetic compass orientation in European Robins, *Erithacus rubecula*. *J. Comp. Physiol. A* 184, 295–299 (1999).
17. Wiltschko, W., Gesson, M. & Wiltschko, R. Magnetic compass orientation of European robins under 565 nm green light. *Naturwissenschaften* 88, 387–390 (2001).
18. Canfield, J., Belford, R., Debrunner, P. & Schulten, K. A perturbation theory treatment of oscillating magnetic fields in the radical pair mechanism. *Chem. Phys.* 182, 1–18 (1994).
19. Kirschvink, J. Microwave absorption by magnetite: a possible mechanism for coupling nonthermal levels of radiation to biological systems. *Bioelectromagnetics* 17, 187–194 (1996).
20. Beason, R. C. & Nichols, J. E. Magnetic orientation and magnetically sensitive material in a transequatorial migratory bird. *Nature* 309, 151–153 (1984).
21. Fleissner, G. *et al.* Ultrastructural analysis of a putative magnetoreceptor in the beak of homing pigeons. *J. Comp. Neurol.* 458, 350–360 (2003).
22. Beason, R. & Semm, P. Does the ophthalmic nerve carry magnetic navigational information? *J. Exp. Biol.* 199, 1241–1244 (1996).
23. Munro, U., Munro, J. A., Phillips, J. B., Wiltschko, R. & Wiltschko, W. Evidence for a magnetite-based navigational 'map' in birds. *Naturwissenschaften* 84, 26–28 (1997).
24. Wiltschko, W., Munro, U., Ford, H. & Wiltschko, R. Effect of a magnetic pulse on the orientation of silvereyes, *Zosterops l. lateralis*, during spring migration. *J. Exp. Biol.* 201, 3257–3261 (1998).
25. Semm, P. & Beason, R. C. Responses to small magnetic variations by the trigeminal system of the bobolink. *Brain Res. Bull.* 25, 735–740 (1990).
26. Beason, R. C. & Semm, P. in *Acta XX Congr. Int. Ornithol.* (ed. Bell, B. D.) 1813–1819 (New Zealand Ornithol. Congr. Trust Board, Wellington, 1991).
27. Batschelet, E. *Circular Statistics in Biology* (Academic, London, 1981).
28. Timmel, C., Cintolesi, F., Brocklehurst, B. & Hore, P. Model calculations of magnetic field effects on the recombination reactions of radicals with anisotropic hyperfine interactions. *Chem. Phys. Lett.* 334, 387–395 (2001).
29. Wiltschko, W. in *Animal Migration, Navigation and Homing* (eds Koenig, K. & Keeton, W.) 302–310 (Springer, Berlin, 1978).

Acknowledgements We thank the Deutsche Telekom AG, especially H. Küpper, T. Loppnow and B. Marx for technical assistance, and F. Galera, S. Hilmer, C. Koschella and S. Münzner for their help with conducting the experiments. J.B.P. acknowledges the National Science Foundation for financial support. Our work was supported by the Deutsche Forschungsgemeinschaft (W.W.) and the Fetzer Institute (T.R.).

Competing interests statement The authors declare that they have no competing financial interests.

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EXHIBIT
IJ 4

Blumberg No. 5136

THE EFFECTS OF MICROWAVE RADIATION ON THE WILDLIFE. PRELIMINARY RESULTS.

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Valladolid (SPAIN)

February, 2003

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INDEX:

INTRODUCTION

For decades a great variety of living beings have been used by men in order to detect possible changes in ecosystems. From lichens, sensitive to pollution for accumulating toxic substances in their tissues, to the birds living in our gardens and buildings, a great variety of organisms have been used as warning signs of the health of the human environment. Moreover trends in numbers over time are of particular interest to nature conservation (Bibby et al. 1992)

Since the second half of the nineties, base stations for mobile telecommunication have been spreading across the urban centres. These base stations have increased the electromagnetic contamination "*electrosmog*" in the urban centres. The fundamental reason for that is that these devices produce 900 for analog and 1800 MHz for digital transmission pulsated waves that interfere in the nervous system of living beings. There exist many scientific studies warning about the danger of this kind of electromagnetic radiation (MRW, microwave radiation) for health in human and living beings (see Hyland, 2000). It is forgotten that not only humans, but also animals who are exposed can suffer such impaiments to their health because of field exposure in the vicinity of transmitting antennas (Marks et al. 1995) and show conspicuous behavioural abnormalities (Löscher & Käs, 1998).

Synergic interactions between electromagnetic fields with different frequencies have already been described on a cellular level (Löscher & Liburdy, 1998). Furthermore, some studies warn about the effects of such radiation on reproduction ; such as, decreases in sperm counts and smaller tube development in rat testes (Dasdag et al., 1999) and increases in embryonic mortality of chickens (Farrel et al., 1997; Youbicier – Simo et al., 1998). The significant increase of micronuclei in erytrhocyte of cattle grazing near a transmitting is an indication of a genotoxic effect of the exposure (Balode, 1996). Genetic effects on hamster and rats of microwaves have been reported in various studies (Garaj-Vrhovac et al., 1991, Lai and Singh, 1995, 1996 y 1997)

The high frequency RF fields produced a response in many types of neurones in the avian Central Nervous System (Beason & Semm, 2002). Microwave irradiation affects central cholinergic activity in the rat (Lai et al., 1987). Also the activity and learning memory tasks of the rat (Thuroczy et al., 2001). That electromagnetic fields (EMFs) emitted by mobile phones have effects on blood-brain barrier permeability (Shivers et al., 1987; Fritze et al. 1997, Töre et al., 2001) and damage some neurones in the brains of the rats (Salford et al., 2003).

In view of the previously known effects of electromagnetic fields it may be possible that the observed abnormalities are related to the microwaves exposure.

"The need for further study are no excuse for inaction. The crucial point is that these figures constitute a strong signal that we can not ignore".

1) POPULATION MONITORING OF HOUSE SPARROWS IN VALLADOLID (SPAIN).*

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*This study was carried out to be published in a scientific review. A summary containing the methodology used and the main results achieved is showed bellow.

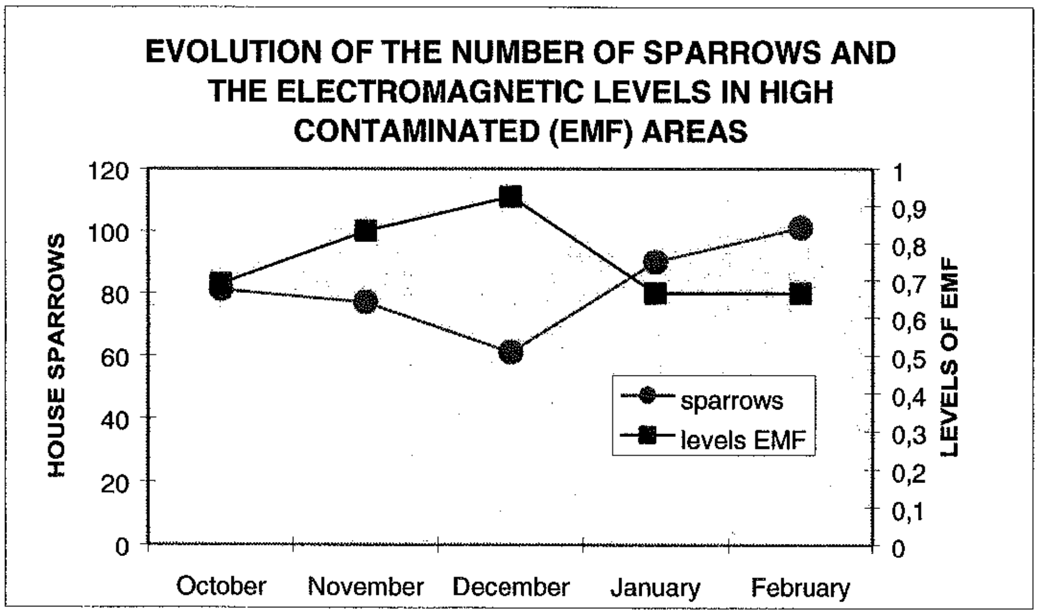
a) Bird Census at point counts of the city.

Method

32 point counts placed in small squares and tree-lined streets of the city were chosen. At each point, a census of the number of sparrows was carried out and the electromagnetic contamination (Microwave radiation) levels were measured once per month between October 2002 and February 2003.

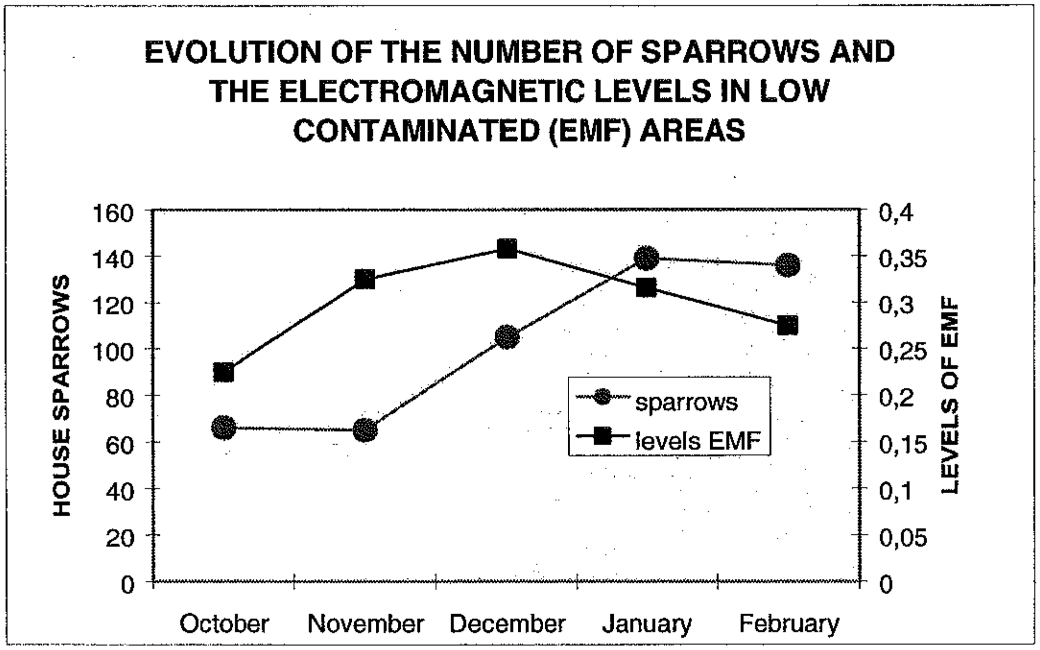
Results and conclusions

During this study the sparrows at several points and streets of the city containing high electromagnetic contamination disappeared. Although, finding sparrows at these points is rare, they occasionally go back looking for some food and settle again when the contamination levels decrease. They gradually leave all the contaminated areas; it doesn't happen quickly. At the same time, the number of sparrows tends to increase in low contaminated areas. Therefore, there is a flow of sparrows moving from high to low contaminated areas.



The levels (mean) in high contaminated areas (EMF) (n= 12) increased from October to December, decreasing subsequently until February; while the number of sparrows (sum) progress in the other way (see chart). A very strong negative correlation R= -0.90 ($p<0.05$) between the mean electromagnetic field levels and the number of sparrows existing in contaminated areas was achieved.

On the contrary, a correlation in low contaminated areas (n= 12 points) wasn't found. (see chart).



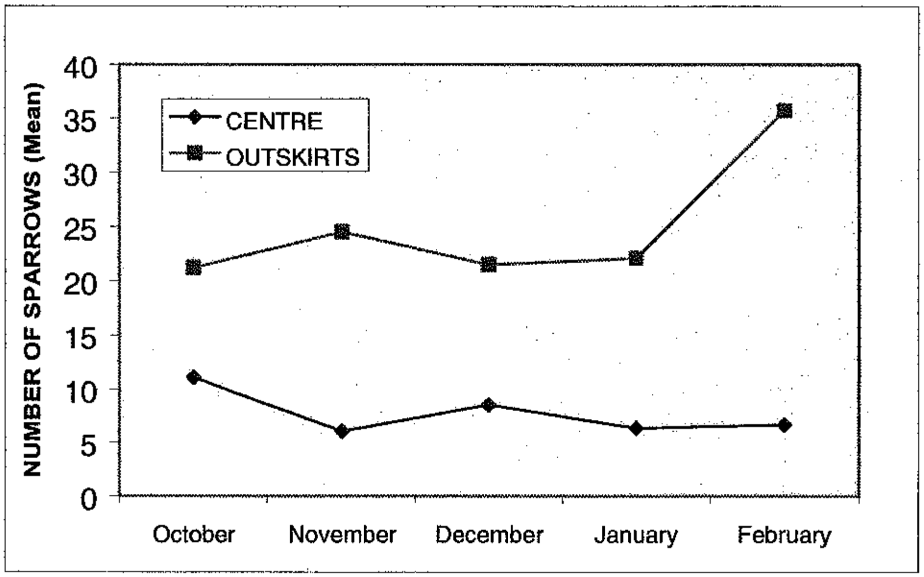
These results show that the number of sparrows increases or decreases depending on the electromagnetic contamination levels (EMF) at these points.
Sparrows are specially abundant in small squares or places well protected by the *screen effect* caused by buildings. They are also found in high contaminated areas but taking refuge in small safe redoubts. They avoid establishing in the antenna's main lobe direction (beam); however, they are sometimes found under it, taking advantage of the *umbrella effect.* Finding sparrows protecting themselves from EMFs in places where the waves don't reach, despite of being near base stations, is not rare because of the *screen effect* caused by buildings. Furthermore, it was observed that some areas where those base stations were took down were reused by sparrows and vice versa.

b) Line transects.

Methods

Two different routes approximately 2 Km long each were planned for the outskirts and the city centre and covered every day. The number of sparrows at each stretch was registered by noting the points where they were found between October 2002 and February 2003.

Provisional results and conclusions.
A gradual disappearance of sparrows in the most contaminated (EMF) streets and squares was observed. The number of sparrows decreased in the city centre, increasing in the outskirts (See the chart).



They are usually found on the ground or in low bushes and in places safe from the waves by walls or buildings causing *screen effect.*
Some specimens presented partial albinism in their feathers or couldn't fly properly.

Note:

Importance of these results related to the decrease of sparrows in the United Kingdom.

The results of the monitoring carried out in Valladolid provide us some possible causes to explain the decrease of sparrows in England.

Electromagnetic radiation could produce the following effects:

- **Effects on reproduction.**
- **Effects on the circulatory and central nervous system.**
- **Effects on the birds health and well-being (microwave syndrome).**
- **Indirect effects due to food shortage caused by electromagnetic contamination (death of insects).**

2) POPULATION MONITORING IN WINTER SLEEPING PLACES.

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A) Starling's sleeping places (*Sturnus vulgaris*)

Method

Daily observation and tracking.

Results and conclusions

Displacement and division of the main sleeping place into smaller ones. Occupation of low contaminated points of the city to stay the night. There was always a rather small group of recurrent specimens that didn't even leave. It was unknown if they were the same specimens or if there was a changing.

B) White Wagtail's sleeping places (*Motacilla alba*)

Method

Monitoring a winter sleeping place in a *Lygustrum japonicum* under a lamppost near a small antenna emitting high microwaves radiation levels.

Results and conclusions

A gradual removal from the source of contamination was observed. Traditionally (prior placing the antenna) the most occupied tree was few metres from the antenna. The specimens moved to far away trees or even to near points, where sleeping places didn't exist before. There was a slow process of desertion of the sleeping place and there was always a rather small group of recurrent specimens that didn't even leave. It was unknown if they were the same specimens or if there was a changing.

3) OTHER COMMENTS ON WILDLIFE AND ELECTROMAGNETIC FIELDS.

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BIRDS

Kestrel (*Falco tinnunculus*)

A general disappearance of the kestrels breeding every year in roofs placed near base stations for mobile telecommunication was stated.

White Stork (Ciconia ciconia)

Although this specie is quite opposed to abandon the nest, even in adverse conditions, the nests placed near the phone mast's radiation beam gradually disappeared. A decrease of young birds and increase of death rate was observed in nests placed near base stations for mobile telecommunication. The safest pinnacles from radiation were used to alight, gradually leaving those highly exposed to the waves.

Rock Dove (domestic) (Columba livia)

Many dead specimens appeared near phone masts areas. They took refuge and formed groups in places safe from radiation. Many carrier pigeons were lost supposed by the existence of electromagnetic fields affecting their sense of direction (see Bardasano & Elorrieta, 2000).

Magpie (*Pica pica*)

Anomalies were detected in a great number of specimens at high contaminated points (MWR); such as, plumage deterioration, especially in head and neck, locomotive problems (limps and difficulties to fly), partial albinism and melanism, especially in flanks, and a tendency to stay long in low parts of the trees and on the ground.

Collared Dove (*Streptopelia decaocto*)

Despite of being an expanding specie, the number of specimens decreased in the whole city. At some points, where they were abundant, they disappeared when Phone masts were settled. Some specimens were found taking refuge in places safe from the electromagnetic waves.

General comment on birds.

The plumage of the birds of the city looked, in general, unflattering, run-down and dull-coloured. This not only occurred to ornamental birds; such as peacocks, but also to wild birds; such as, tits, great tits, House sparrows, etc.

Anomalous behaviour, probably caused by a lack of food (shortage of insects?), were observed; such as, excessively trusting great tits, tits and sparrows even eating breadcrumbs from our hands.

In some tracked nests (blackbird), the eggs never hatch after the incubation being abandoned by the mother.

BATS

Since 1998 a study in a free-tailed bat colony (*Tadarida teniotis*) has been carried out. (Balmori, 2003). During the study the number of bats decreased so much that the control (ringing) works had to be interrupted. Several phone masts affecting directly were placed 80 metre from the colony (they live in an air chamber).
The number of bats (*Pipistrellus pipistrellus*) decreased in some areas. Furthermore, a dead specimen of *Myotis myotis* was found near a small antenna in the city centre.

INVERTEBRATES

There was no life near base stations for mobile telecommunication. A decrease of insects and arachnids near those base stations was detected and corroborated by engineers and antenna's maintenance staff. Lack of fly in the house near the phone mast, not even in summer. See Wellenstein (1973) for lack of beas near high tension lines, and http://canterbury.cyberplace.org.nz/ouruhia/ for lack of beas near radio tower AM/FM.
The disappearance of insects could have an influence on bird's weakening caused by a lack of food, especially at the first stages in young bird's life.

DOMESTIC ANIMALS

There was proof of a frequent death in domestic animals; such as, hamsters and guinea pigs, living near base stations for mobile telecommunication.
There was a deterioration in the plumage of peacocks and other ornamental birds living in urban parks (lack of shine, beardless rachis, etc). We must mention that plumage deterioration is the first sign of weakening or illnesses in birds. Damaged feathers are a sure sign of stress.

TREES AND BUSHES

The tops of trees are dried up where the main beams are directed to and they seem to be most vulnerable if they have their roots or are close to the water (see Belyavskaya, 2001 and http://canterbury.cyberplace.org.nz/ouruhia/)
The plants placed inside the antenna's main beam showed a gloomy and unhealthy appearance, possible growth delays and a higher tendency to contract plagues and illnesses.

4) MONITORING THE WILD BIRDS NESTING IN "CAMPO GRANDE", AN URBAN PARK IN VALLADOLID (SPAIN).

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MATERIALS AND METHODS

During the spring of 1996, 1997, 1998 and 2002 a research has been carried out to find out the number of existing species and to quantify the couples of wild birds nesting in the most important and emblematic urban park of Valladolid and their evolution. In 1996, 1997 and 1998 between two and four visits were carried out at favourable times. Whereas, in 2002 a more exhaustive tracking was carried out by covering eight different routes during the following dates: 07/04/02, 13/04/02, 23/04/02, 28/04/02, 11/05/02, 26/05/02, 02/06/02 and 09/06/02. To make an inventory of the species nesting in this park, favourable climate days neither windy nor rainy were chosen.

The park was fully covered in each visit between 8 a.m. and 10 a.m. by following the same route at about 0.6 miles/hour. For each contact the exact place, specie, brood category (male songbird, territorial behaviour, couple, way of distracting, adult going inside the nest, adult bringing food into the nest etc.) and number of specimens was noted. The sight of isolated specimens in silence was not counted as a clear evidence of breeding. Each probable and sure contact to breed was noted as a couple.

RESULTS AND DISCUSSION

Approximately 500 contacts with wild birds were achieved during the study. 15 bird species that could be classified as residents in the park during the breeding were recorded. Furthermore, a changeable number of specimens of other different species only pass through the park, specially in April.

According to the results achieved in the different samples, the resident species have been classified into three different categories, as follows:

1) Species present during the study, maintaining their number in 2002.

Great spotted woodpecker (*Dendrocopos major*) : 1 couple.
Magpie (*Pica pica*) : 3 – 4 couples.
Blue tit (*Parus caeruleus*) : 3 couples.
Robin (*Erithacus rubecula*) : 4 – 5 couples.
Blackcap (*Sylvia atricapilla*) : 5 – 8 couples.

2) Species present during the study, decreasing drastically their number in breeding season in 2002.

Blackbird (*Turdus merula*) : from 8 to 5 couples.
Great tit (*Parus major*) : from 4 to 1 couple.

Serin (*Serinus serinus*) : from 5 to 1 couple.
Greenfinch (*Carduelis chloris*) : from 7 to 1 couple.
Coal tit (*Parus ater*) : from 2 to 1 couple.
Wren (*Troglodytes troglodytes*) : from 5 to 1 couple.
Collared Dove (*Streptopelia decaocto*) : 50% of nesting specimens dropped between 1998 and 2002.

Relevant decreases, most of them higher than the 50%, have been found during the month of May in 2002.

3) Resident species usually breeding in 1996, 1997 and 1998 but not sighted in any of the visits carried out in 2002.

Green woodpecker (*Picus viridis*)
Short toed treecreeper (*Certhia brachydactyla*)
Bonelli's warbler (*Phylloscopus bonelli*)

These species have disappeared in some moment between 1999 and 2001 because they were constantly in the park (the Bonelli´s warbler just in spring) between 1996 and 1998.

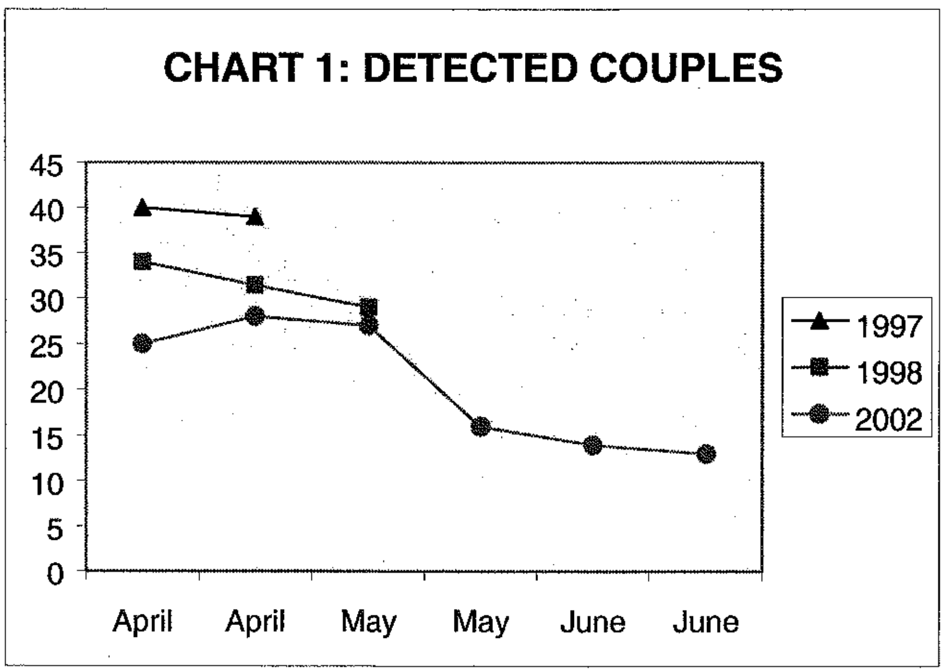
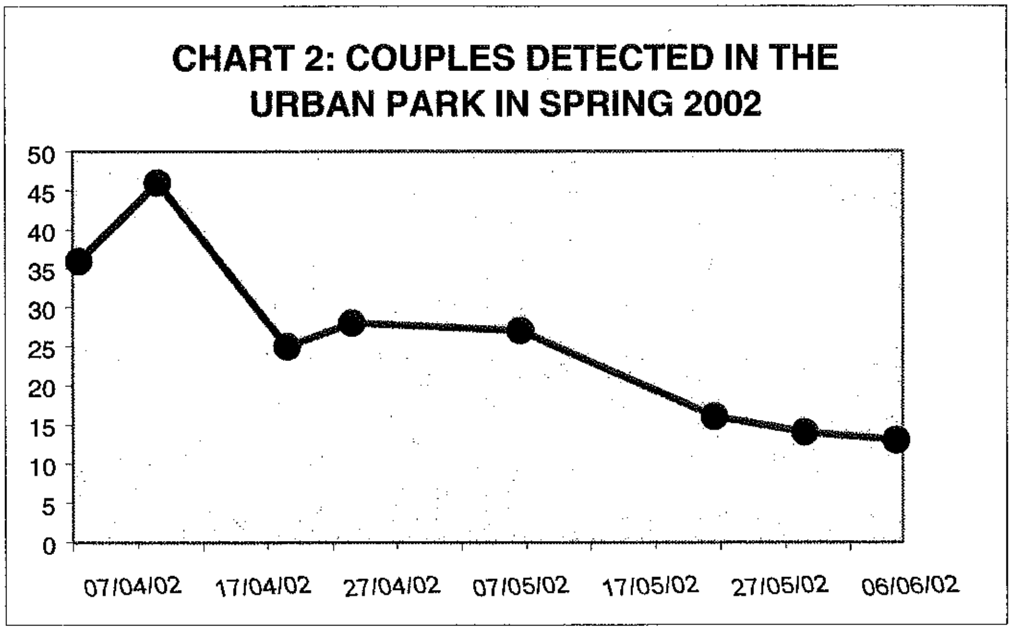


Chart 1 shows a comparison between the number of couples in 1997, 1998 and 2002. A decrease in 1997 and 1998 is observed, intensified in May 2002, from 30 or 40 couples to only 15 couples in the final sampling days (see chart 2).

Chart 2 shows an evolution in the number of couples detected in spring of 2002. It shows a high decrease in May, dropping more than half of the nesting couples, and the common path peak in the beginning of April showing the birds passing by the park during the spring migrations and not breeding inside it.



During the research carried out in 2002 some areas called “silence areas”, where different couples usually bred, specially greenfinches and finches serin, that totally disappeared in 2002, have been found.

As a conclusion, we could say that during the research in 2002 the disappearance of three species, 20% of the total breeding species between 1996 and 1998, has been proved. Furthermore, a decrease in the number of couples of seven species (47%) usually arriving to the area and leaving it without breeding has been achieved. It is unknown if the specimens staying are always the same or different but population stability has been found in five different species (33%) during the study. These results show that 67% of the birds in *Campo Grande* have suffered an important population decrease or have totally disappeared between 1998 and 2002.

Since birds are good warning signs of their habitat’s health, the increasing impoverishment of birds detected in *Campo Grande* in a short period of time (between 1996 and 2002) shows the recent appearance of some environmental cause having serious consequences on this ecosystem.

The cause provoking such decrease must be recent and correlative in time. In this time the air pollution (SO_2, NO_2, CO and Benzene) drop. So, the only possible cause found is the increasing establishments of base stations for mobile telecommunication; at least five of them were placed in three different points at < 100 meters from the park.

In view of the absence of any other convincing explanation for such decrease, all the electromagnetic transmission levels existing in the different areas were measured by means of an electromagnetic field meter equipment, that show relative levels. This way, it has been proved that the electromagnetic radiation existing in the park has been multiplied by 3 or 20 during this study, compared with the existing in free base stations for mobile telecommunication areas. This could mean that this radiation affecting the birds could be quite increased in the trees. We must also bear in mind the different results achieved at each point, depending on the time, weather and mobiles connected in each moment.

By analysing these results it seems that these birds nest in breeding areas and start breeding but as the spring draws on they leave those contaminated areas creating "silence areas" with neither male songbirds nor breeding couples. The main reason for such population decrease could be, according to these results, a decrease in the perfect available breeding habitats causing failed breeding in contaminated areas. The probable reason for the decrease of some species instead of others could be a preference in habitats and habits, decreasing highly those species nesting in the top of the trees, roofs and phone wires or breeding in higher places and being more affected than those nesting in lowlyings and lands or breeding in safer places. Apart from all these reasons, it is possible that each specie shows different sensitivity to this radiation, complicating the interpretation of the achieved results.

It seems that this hypothesis is the only one correlating exactly in time. We must also bear in mind the existence of thousands of publications in scientific literature showing worrying signs of pernicious effects on living beings caused by electromagnetic radiation, specially by the ones using low pulsated waves transporting low frequency harmonics, such as the ones in mobile telecommunication. The results achieved confer a strong support to the hypothesis set out in this study.

5) Evidence of a conection between Sparrow decline in United Kingdom and the introduction of Phone mast GSM (Global system for mobile communication)

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"Disappearance of the Sparrow and the introduction of phone mast GSM correlate closely in terms of time".

Evidence:

Since the second half of the nineties Base Stations for mobile telecommunication have been spreading across the urban centres. These base stations have increased the electromagnetic contamination "electrosmog" in the urban centres. The fundamental reason is that these devices produce 900 and 1800 MHz pulsated waves that interfere in the nervous system of living beings. There exist many scientific studies that warn about the danger for health in human and living beings of this kind of electromagnetic radiation electromagnética (MRW: microwave radiation). (see for example Hyland, 2000).

⇒ The circumstantial evidence of a connection between Sparrow decline and the introduction of Telecommunication Mast and Base Stations is strong. As the disappearance of the house Sparrow from the large cities correlates with the introduction of phone masts, the possibility that such cell masts (towers) are involved surely requires immediate investigation.

⇒ The high frequency RF fields produced a response in many types of neurons in the avian Central Nervous System.

⇒ Besides, some studies warn about the effects of these radiations on reproduction: Decreases in sperm counts and smaller tube development in rat testes (Dasdag et al., 1999) and increases in embryonic mortality of chickens, (Youbicier-Simo, et al., 1998).

⇒ Why have British Sparrow populations indeed collapsed in big cities but not in small towns?: The number of Telecommunication Masts in big cities and the use of mobile phones, in general, is much greater than in small towns. Big cities usually have more electromagnetic contamination, but this differs between areas (vicinity of Masts) and because of this the decline of these birds does not happen to the same degree in different parks or neighbourhoods or different cities. Small towns usually have the telecommunication masts located away from the urban centre because this is sufficient to maintain the coverage. Because of this birds are less affected in small towns and villages.

⇒ Telecommunication Masts usually are installed in high places in order to achieve more coverage for the signal. For this reason there is lower density power in lower places. These waves impact to the species in different ways depending on the breeding height, the height of singing, feeding, nest location, kind of nest etc. This is the reason for the decline of species that frequent roofs, aerials, phone wires or those with higher breeding height such us House Sparrows (*Passer domesticus*), Starlings (*Sturnus vulgaris*) Magpies (*Pica pica*), but not those that live near the ground and vegetation like Blackbirds (*Turdus merula*), Robins (*Erithacus rubecula*), Wrens (*Troglodytes troglodytes*), or those that breed in cavities where they are more protected like the Blue Tit (*Parus caeruleus*), Great Tit (*Parus major*), Coal Tit (*Parus ater*). Apart from that, it is likely that each specie will show different susceptibility to these radiations.

⇒ In November 1999, in Scotland over one third of all Scottish Local Planning Authorities adopted or publicly committed themselves in to adopting precautionary policies as a direct result, by choosing to keep transmitter masts away from schools and residential areas.
Two years later the demise of the House Sparrows appears to have been reversed in Scotland (Paul Kelbie 10/11/2001, The Independent).

⇒ It is most likely that the same will happen in Northern Ireland very soon as there will be Planning controls on mobile phones masts, and the new regulations will be stricter than any other region of the U.K. (Marie Foy, 11/4/2002, Belfast Telegraph). So we might expect an increase in House Sparrows and Starlings in Northern Ireland in the next few years.

"The electromagnetic field is the perfect secret agent: you cannot see it, you cannot smell it, you cannot hear it, you cannot feel it and its effects are slow but relentless."

References

Balmori, A. 2003. Contribution to the knowledge of the biology and social behaviour of the free-tailed bat (*Tadarida teniotis*). *Galemys*, 15 (n.e.) *in press.*

Balode, S. 1996. Assessment of radio-frecuency electromagnetic radiation by the micronucleus test in bovine peripheral erythrocytes. *Sci. Total. Environm.*, 180: 81-85

Bardasano, J.L. & Elorrieta, J.I. 2000. *Bioelectromagnetismo. Ciencia y Salud.* McGaw-Hill.

Beasond R. C. & P. Semm. 2002. Responses of neurons to an amplitude modulated microwave stimulus. *Neuroscience Letters.*

Belyavskaya, N.A. 2001. Ultrastructure and calcium balance in meristem cells of pea roots exposed to extremely low magnetic fields. Adv. Space Res, 28: 645-650

Bibby, C.J., N.D. Burgess & D.A. Hill. 1992. Bird Census Techniques. BTO and RSPB.

S. Dasdag, M.A. Ketani, Z. Akdag, A.R. Ersay, I. Sar, Demirtas Ö.C, M.S. Celik. 1999. Whole - body microwave exposure emmited by cellular phones and testicular function of rats. *Urological Research*, 27 : 3, 219-223.

Farrel, J.M., Litovitz, T.L., Penafiel, M. et al. 1997. The effect of pulsed and sinusoidal magnetic fields on the morphology of developing chick embryos. *Bioelectromagnetics*, 18: 431-438.

Fritze K, Sommer C, Schmitz B, Mies G, Hossman K, Kiessling M et al. 1997. Effect of global system for mobile communication (GSM) microwave exposure on blood-brain barrier permeability in rat. *Acta Neuropathol* (Berlin) 94:465-470.

Garaj-Vrhovac V, Horvat D, Koren Z. (1991) The relationship between colony-forming ability, chromosome aberrations and incidence of micronuclei in V79 Chinese hamster cells exposed to microwave radiation. *Mutat Res* 263:143-149.

Hyland, G.J. 2000: Physics and biology of mobile telephony. *The Lancet*, vol 356: 1-8.

Lai, H., Horita, A., Chou, C.K. and Guy, A.W., 1987. Low-level microwave irradiation affects central cholinergic activity in the rat. *J Neurochem* 48:40-45.

Lai H, Singh NP. (1995) Acute low-intensity microwave exposure increases DNA single-strand breaks in rat brain cells. *Bioelectromagnetics* 16:207-210.

Lai H, Singh NP. (1996) DNA Single- and double-strand DNA breaks in rat brain cells after acute exposure to low-level radiofrequency electromagnetic radiation. *Int J Radiat Biol* 69:513-521.

Lai H, Singh NP. (1997) Melatonin and a spin-trap compound blocked radiofrequency radiation-induced DNA strand breaks in rat brain cells. *Bioelectromagnetics* 18:446-454.

Löscher, W. and R.P. Liburdy. 1998. Animal and cellular studies on carcinogenic effects of low frequency (50-60 Hz.) magnetic fields. *Mutation Res.*

Löscher, W. and Käs, G. 1998. Conspicuous behavioural abnormalities in a dairy cow herd near a TV and Radio transmitting antenna. *Practical Veterinary surgeon*, 29: 5, 437-444.

Marks, T.A., C.C. Ratke and W.O. English. 1995. Strai voltage and developmental, reproductive and other toxicology problems in dogs, cats and cows: a discusion. Vet. Hum. Toxicol, 37: 163-172.

Salford, L.G., Brun, A.E., Eberhardt, J.L., Malmgren, L. & Persson, B.R. 2003. Nerve cell Damage in Mammalian Brain after Exposure to Microwaves from GSM Mobile Phones. *Environmental Health Perspectives.*

Shivers R, Kavaliers M, Teskey G, Prato F, Pelletier R. 1987. Magnetic resonance imaging temporarily alters blood-brain barrier in the rat. *Neuroscience Letters* 76:25-31.

Töre F, Dulou P-E, Haro E, Veyret B, Aubineau P. 2001. Two-hour Exposure to 2 W/kg, 900 MHz GSM microwaves induces Plasma Protein Extravasation in Rat Brain. In: *Proceedings from the 5th International Congress of the European Bioelectromagnetics Association*, 6 September 2001 (Hietanen M, Jokela K, Juutilainen, J, eds). Finnish Institute of Occupational Health, Helsinki , 43-45.

Thuroczy, G., Hernadj, I. and Kelleny, L. 2001. Activity and learning memory task of the rat, *Bioelectromagnetics*, 27.

Wellenstein, G. 1973. "The influence of high tension lines on honey bee colonies, *Zeitschrift fur Angewandte Entomoligie*, 74: 86-94

Youbicier-Simo BJ, Lebecq JC, Bastide. 1998. Mortality of chicken embryos exposed to EMFs from mobile phones. Presented at the Twentieth Annual Meeting of the Bioelectromagnetics Society, St. Pete Beach, FL, June 1998.

EXHIBIT
IJ 5

Electromagnetic Biology and Medicine, 26: 63–72, 2007
DOI: 10.1080/15368370701205693
The original publication is available at www.informaworld.com

A Possible Effect of Electromagnetic Radiation from Mobile Phone Base Stations on the Number of Breeding House Sparrows (Passer domesticus)

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A possible effect of long-term exposure to low-intensity electromagnetic radiation from mobile phone (GSM) base stations on the number of House Sparrows during the breeding season was studied in six residential districts in Belgium. We sampled 150 point locations within the 6 areas to examine small-scale geographic variation in the number of House Sparrow males and the strength of electromagnetic radiation from base stations. Spatial variation in the number of House Sparrow males was negatively and highly significantly related to the strength of electric fields from both the 900 and 1800MHz downlink frequency bands and from the sum of these bands (Chi^2-tests and AIC-criteria, $P < 0.001$). This negative relationship was highly similar within each of the six study areas, despite differences among areas in both the number of birds and radiation levels. Thus, our data show that fewer House Sparrow males were seen at locations with relatively high electric field strength values of GSM base stations and therefore support the notion that long-term exposure to higher levels of radiation negatively affects the abundance or behavior of House Sparrows in the wild.

Keywords Antenna; Bird; Electromagnetic radiation; GSM base station; Non thermal effect.

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Introduction

Mobile phones, also called cellular phones or handies, are now an integral part of modern life. The widespread use of mobile phones has been accompanied by the installation of an increasing number of base station antennas on masts and buildings. GSM base stations emit electromagnetic fields at high frequencies in the 900 and 1800 MHz range (= downlink frequency bands), pulse modulated in low frequencies (Hyland, 2000). In recent years, increased public awareness and scientific research have questioned to what extent the non thermal exposure to low-intensity electromagnetic fields may affect the health, reproduction, well-being and behaviour of humans and other organisms. There is an active and, as yet, unsettled controversy about current safety standards. Some researchers and national committees advised more stringent safety standards, based on experimental data with reported biological effects from (chronic) non thermal exposures (Hyland, 2000; Belyaev, 2005a, b).

There are studies showing frequency-specific biological effects, and studies demonstrating that a high frequency signal modulated at certain low frequencies, or a signal that is pulsed, has more harmful effects than an unmodulated, steady carrier. These so-called 'window effects' greatly complicate any attempt to understand the relationship between electromagnetic radiation and health (Adey, 1981; Hyland, 2000; Lai, 2005; Belyaev, 2005a).

Public and scientific concern were also raised by results of some epidemiologic studies that examined the effects of long-term exposure on humans living near mobile phone base stations. A growing number of studies point to the existence of effects, ranging from changes in cognitive performance and sleep disturbances to serious illness and disablement, with even higher cancer rates (Santini et al., 2002; Navarro et al., 2003; Bortkiewicz et al., 2004; Eger et al., 2004; Wolf and Wolf, 2004; Hutter et al., 2006; Abdel-Rassoul et al., 2006).

Short-term laboratory experiments used mice, rats, chickens and other birds as study models to better understand the possible implications of electromagnetic fields on organismal functioning. In many studies however, 'mobile communication-like' signals were investigated that in fact were different from the real exposures in such aspects as intensity, carrier frequency, modulation, polarisation, duration and intermittence (Belyaev, 2005a, b; Lai, 2005).

Studies of the effects of exposure to electromagnetic fields on populations of wild birds can provide further insights into the potential impacts on animal and human health (Fernie and Reynolds, 2005). Birds are candidates for being good biological indicators for low-intensity electromagnetic radiation: they have thin skulls, their feathers can act as dielectric receptors of microwave radiation, many species use magnetic navigation, they are very mobile and possible psychosomatic effects are absent (Bigu-del-Blanco and Romero-Sierra, 1975; Balmori, 2005). Field studies of wild populations can also reveal possible effects of long-term exposure to radiation from GSM base stations. In addition, species like the House Sparrow (*Passer domesticus*) are especially of interest because a large proportion of the birds use higher breeding height locations like roof spaces (Wotton et al., 2002) where potentially higher levels of base station radiation are present.

Here we report results of a preliminary study that explored putative effects of electromagnetic radiation emitted by mobile phone base stations on the number of House Sparrows during the breeding season. Specifically, we examined small-scale geographic variation within each of six study areas in both the number of birds and the strength of electromagnetic radiation. If electromagnetic fields from GSM base stations have adverse effects on bird populations, this should result in a decreasing number of House Sparrows with increasing levels of radiation.

Materials and Methods

Data collection

We determined, during the spring of 2006, the number of House Sparrow males and the strength of electromagnetic radiation from mobile phone (GSM) base stations at 150 locations that were distributed over six residential areas in the region of Gent – Sint-Niklaas (province of East Flanders, Belgium). The study areas were similar in overall appearance, with abundant hedges, bushes and other vegetation between the houses, and with one or more GSM base stations nearby.

The 150 study locations were selected in advance as points on a map (ArcGIS). All locations were situated along small roads within the residential areas and were at variable distances from the nearest GSM base station (mean = 352 m, range = 91 - 903 m, about 90% at 100 - 600 m). The number of locations, and study dates, within each area were: Lokeren - Eksaarde (N = 19; April 9), Lokeren - Spoele (N = 27, April 15), Lokeren - Bergendries (N = 17, April 17), Sint Niklaas - Clementwijk (N = 25, April 20), Gent- Wondelgem (N = 38, April 25) and Gent - Mariakerke (N = 24, April 26).

At each location, a point count of five minutes (see 'point transect count' in Bibby et al., 2000; Hustings et al., 1985) was made of the number House Sparrow males that were singing or otherwise visible within a distance of ca. 30 m. Sightings of birds were done with binoculars (Swarovski EL 10x42). Counts were restricted to the morning hours (7-11h), when male House Sparrows are most active (Hustings et al., 1985; Van Dijk, 2004), on days with favourable weather conditions (no rain, little wind, sunny, normal temperatures).

Simultaneously, we measured the maximum value (peak hold) of the electric field strength (in V/m) from the downlink frequencies of GSM 900 MHz (925-960 MHz) and GSM 1800 MHz (1805-1880 MHz) base station antennas. Measurements at each location were made during two minutes for each frequency band. The electric field strength was measured using a portable calibrated high-frequency spectrum analyser (Aaronia Spectran HF-6080; typ. accuracy ± 3 dB) with calibrated EMC directional antenna (HyperLOG 6080; logarithmic-periodic). To measure the maximum radiation values, the EMC antenna was turned around in all directions.

Additional antennas for the new UMTS-system are now being installed on several existing base stations in Belgium. Therefore, at several locations within each study area, the electric field strength from the downlink frequencies of UMTS antennas (2110-2170 MHz) was also checked, but no significant signals were found. Consequently, the UMTS variable was not taken into account for further analysis.

Data analyses

The sum (Egsm) of the measured GSM 900 MHz (Egsm900) and 1800 MHz (Egsm1800) electric field strength values was calculated using the formula: $Egsm = \sqrt{Egsm900^2 + Egsm1800^2}$ (Electronic Communications Committee, 2003). Prior to all analyses, the electric field strength variables were logarithmically transformed to achieve normality of their frequency distributions.

We explored relations between the number of House Sparrow males (dependent variable) and each of the three electric field strength variables. As the dependent variable consists of count data and is hence discontinuous, standard regression (or correlation) techniques are inappropriate. Instead, we used Poisson regressions (i.e., generalized linear models) with a log link function to examine putative relationships. Preliminary analyses indicated that significant variation among the six study areas was present for all variables (ANOVA, $P < 0.001$). Therefore we included "area" as a categorical factor in all models and considered it to be a proxy for all unknown, and hence unmeasured variables causing among area variation in the number of House Sparrows (e.g., habitat characteristics, food availability, temporal differences among censuses). Statistical analyses were done with S-PLUS v. 6.2.

Results

The number of House Sparrow males varied between zero and four at the different locations. The measured electric field strengths were seldom higher than 1 V/m, and most often well below that value (Table 1).

To explore the putative effects of area, electric field strength and their interaction on the number of House Sparrows, we performed separate analyses for each of the three radiation variables. As no significant interaction effect between area and electric field strength was detected in any of the three analyses (Chi²-tests and AIC-criteria, $P > 0.20$), we excluded the interaction term from further treatments. The final regression models were highly similar for the three electric strength variables. They revealed significant variation among study areas (Chi²-tests, $P < 0.001$), and a highly significant negative effect of electric field strength on the number of House Sparrow males (Chi²-tests and AIC-criteria, $P < 0.001$; Figure 1). Estimates of the scaled deviance (1.06 – 1.14) were very close to 1, and examination of the regression residuals revealed no clear patterns or deviations from normality. These observations indicate an adequate fit of the models to the data.

Table 1

Summary statistics (mean, 95% confidence interval, range) of the number of House Sparrow males and electric field strength variables in the six study areas. Means and confidence limits of the radiation variables were calculated after back-transformation of the logarithmically transformed data; the confidence intervals are therefore asymmetrical around the mean

Study area		Number of House Sparrow males	E_{gsm900} (V/m)	$E_{gsm1800}$ (V/m)	E_{gsm} (V/m)
1: Lokeren - Eksaarde	mean	1.5	0.153	0.075	0.193
	95% CI	0.8 – 2.2	0.108 - 0.216	0.046 - 0.123	0.139 - 0.270
	Min - Max	0 – 4	0.036 - 0.494	0.015 - 0.333	0.052 - 0.505
2: Lokeren - Spoele	mean	1.9	0.084	0.083	0.130
	95% CI	1.5 – 2.3	0.059 - 0.120	0.058 - 0.120	0.091 - 0.183
	Min - Max	0 – 4	0.008 - 0.327	0.013 - 0.394	0.016 - 0.412
3: Lokeren - Bergendries	mean	0.8	0.245	0.017	0.247
	95% CI	0.3 - 1.3	0.186 - 0.323	0.009 - 0.031	0.187 - 0.327
	Min - Max	0 - 3	0.052 - 0.537	0.004 - 0.125	0.052 - 0.551
4: Sint Niklaas - Clementwijk	mean	1.0	0.130	0.056	0.148
	95% CI	0.6 - 1.4	0.098 - 0.173	0.039 - 0.082	0.111 - 0.197
	Min - Max	0 - 3	0.019 - 0.412	0.009 - 0.231	0.021 - 0.469
5: Gent - Wondelgem	mean	1.3	0.109	0.040	0.121
	95% CI	0.9 - 1.6	0.079 - 0.151	0.030 - 0.054	0.089 - 0.165
	Min - Max	0 - 4	0.016 - 1.006	0.009 - 0.321	0.022 - 1.056
6: Gent - Mariakerke	mean	0.8	0.043	0.080	0.160
	95% CI	0.3 - 1.2	0.024 - 0.078	0.049 - 0.130	0.107 - 0.240
	Min - Max	0 - 4	0.006 - 1.022	0.017 - 0.824	0.040 - 1.023

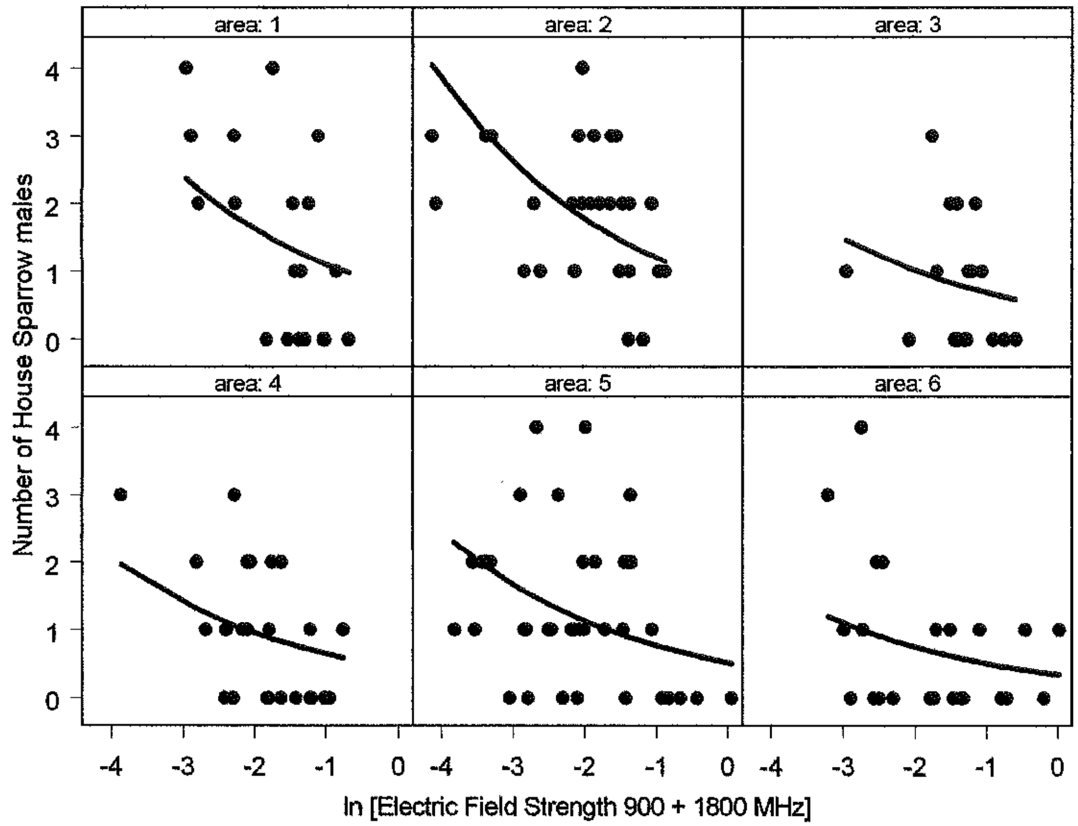

Figure 1. Scatterplots of the observed number of House Sparrow males as a function of the sum (Egsm) of GSM 900 MHz and GSM 1800 MHz electric field strength values (logarithmic scale) at the different locations within each of the six study areas. Regression lines were obtained by Poisson regressions and incorporated the effects of area and radiation intensity (see text).

We further explored the separate effects of electromagnetic radiation at the two frequencies by modelling the number of House Sparrow males as a function of area, electric field strength at 900 MHz, electric field strength at 1800 MHz, and their interactions. The final model retained included highly significant effects of area and the two electric field strengths (Chi^2-tests and AIC-criteria, $P < 0.001$) and a marginally significant interaction effect between both field strengths (Chi^2-test, $P = 0.02$). This strongly suggests that the electromagnetic radiations at both frequencies have complex additive effects on the number of House Sparrow males.

Overall, analyses indicated that the strength of all three radiation variables decreased with increasing distance to the nearest base station (F-tests, $P < 0.001$). We therefore examined whether the negative relation between the number of birds and strength of radiation was induced by variation among sampling locations in the distance to GSM base stations. Upon adding distance to the nearest base station as an additional factor to the regression models that included area and electric field strength, distance did not account for a significant portion of the residual variation (Chi^2-tests and AIC-criteria, $P > 0.50$). Conversely, when we forced distance as the first factor into the regression equations, both area and radiation strength were subsequently selected as highly significant factors (Chi^2-tests and AIC-criteria, $P < 0.001$).

Discussion

Our results indicate that spatial variation among sampling locations in the number of House Sparrow males was negatively related to the strength of electric fields emitted by GSM base stations. Importantly, this relation was highly similar among the six study areas, as evidenced by the non-significant interaction effects between area and electric field strength, despite differences among areas in both the number of birds and radiation levels. Moreover, the negative association was detected for electric field strengths from both the 900 and 1800 MHz frequency bands and from the sum of these frequency bands. Our analyses also revealed that the negative relation between the number of birds and strength of radiation was not a simple consequence of differences among sampling locations in distances to the nearest GSM base station. This can probably be attributed to variations in the orientation, position and number of antennas and to the shielding effects and multiple reflections from structures like buildings and trees, which affect local levels of exposure to electromagnetic radiation. Thus, our data show that fewer House Sparrow males were seen at locations with relatively high electric field strength values of GSM base stations and therefore support the notion that long-term exposure to higher levels of radiation negatively affects the abundance or behaviour of House Sparrows in the wild.

Nevertheless, our study should be considered as preliminary for several reasons. First, sampling locations were each visited only once, such that counts of the number of House Sparrow males and measurements of electric field strength are subject to some variation and estimation error. However, it is most likely that these errors are randomly distributed among locations. We also note that a single visit during the peak of the breeding season (April – May) is considered to be adequate to locate House Sparrow breeding territories (Hustings et al., 1985; Van Dijk, 2004). Second, because of the short study period, we ignore whether differences in bird counts reflect variation in abundance of breeding birds or in short-term behavioural responses like the tendency to sing. However, a decrease in singing intensity will result in a decrease of reproductive success and ultimately a decline of population size. Third, only the radiation from GSM base station antennas was measured. Probably, the distribution of possible other significant electromagnetic signals will be random, but due to the lack of measurements in other frequency bands (except for UMTS), this remains an object of further study. Fourth, as with all descriptive field studies, we cannot provide evidence for a causal relationship between radiation levels and the number of birds. Nevertheless, the fact that we found a highly similar pattern in each of the six study areas strengthens the possibility that the relationship is not a spurious one.

There are several unpublished and anecdotal reports about birds and mobile phone base stations, but we know of only one other published study that examined the effects of electromagnetic radiation from mobile phone base stations on wild bird populations. Balmori (2005) found a significantly lower number of White Stork (*Ciconia ciconia*) fledglings in nests exposed to relatively high electromagnetic radiation (2.36 ± 0.82 V/m) than in nests receiving lower levels of radiation (0.53 ± 0.82 V/m). Together with observations on aberrant behaviours of the adult birds, these results suggest that electromagnetic radiation interferes with reproduction in this wild population.

What could be the underlying mechanisms of the (putative) negative effects of radiation from GSM base stations on wild bird populations? Because all measured electric field strength values were far below what is required to produce heating as low as 0.5 °C (i.e., 10 mW/cm² or ca. 194 V/m; Bernhardt, 1992), the effects should be considered as non thermal at very low intensities.

Non thermal effects of microwaves on birds were reported already 40 years ago (Tanner, 1966; Tanner et al., 1967). Most studies indicate that exposure of birds to electromagnetic fields generally changes, but not always consistently in effect or in direction, their behaviour, reproductive success, growth, development, physiology, endocrinology, and oxidative stress (Wasserman et al., 1984; Grigor'ev et al., 2003; Fernie and Reynolds, 2005). Of special relevance within the context of our research are laboratory studies that demonstrate negative effects of electromagnetic radiation from mobile phones on the development and survival of bird embryo's (Farrel et al., 1997; Youbicier-Simo and Bastide, 1999; Grigoriew, 2003).

Bird feathers are known to act as dielectric receptors of high frequency electromagnetic fields and some experiments indicate that audiofrequency pulse-modulated high frequency fields may induce piezoelectric effects in the feathers (Bigu-del-Blanco and Romero-Sierra, 1975a, b). These results are important in view of the fundamental role that feathers play in the life of birds and in the influence of environmental factors on bird behaviour. Experiments also indicated that microwave radiation can have the same averse effects on birds in flight as those observed in caged birds (Romero-Sierra et al., 1969).

Several bird species also use magnetic navigation (Liboff and Jenrow, 2000; Muheim et al., 2006) and can become disorientated when exposed to weak (< 1/50 of geomagnetic field strength) high frequency magnetic fields (Ritz et al., 2004; Thalau et al., 2005). The available evidence concerning magnetoreception suggests that birds use a radical pair mechanism for a chemical compass, and a mechanism based on magnetite particles (Wiltschko and Wiltschko, 2005; Mouritsen and Ritz, 2005). Magnetite is an excellent absorber of microwave radiation at frequencies between 0.5 and 10.0 GHz through the process of ferromagnetic resonance (Kirschvink, 1996), so that interaction with electromagnetic fields from mobile phone base stations might be possible.

In an experiment with Zebra Finches (*Taenopygia guttata*) that were temporary (10 minutes) stimulated with a pulsed electromagnetic field similar to the signal produced by mobile phones with carrier frequency 900 MHz, significant non thermal changes in the amount of neural activity by more than half of the brain cells were detected (Beasond and Semm, 2002). The effect did not appear tot be limited to magnetic sensory cells, but occurred in any part of the brain. The authors postulate that similar neural responses to different frequencies point toward a common mechanism of low frequency modulation, perhaps at the cell membrane. Such a stimulus might mimic a natural mechanism involved in cell communication. Although the peak electric field strength used in that experiment (0.1 mW/cm^2 = approx. 19 V/m; Beasond and Semm, 2002) was higher than the values measured in our study, results from other studies indicate that a long-term exposure at low intensities can produce the same effects as a short-term exposure at higher intensity (D'Andrea et al., 1986a, b; Lai, 2005; Belyaev, 2005a). This suggests that the non thermal effects of relatively weak electromagnetic radiation from mobile phone base stations can accumulate over time and have significant implications, as detected by several pilot epidemiological studies on humans (see Introduction).

Radiation from GSM base stations may also affect the local abundance of insects or other invertebrates and thereby indirectly influence the number of House Sparrows. Although adult House Sparrows are mainly seed-eaters, they need insects and other invertebrates to feed their young, such that it is likely that they will prefer areas with high abundance of invertebrates at the beginning of the breeding period. Several researchers have postulated that the lack of invertebrates might be an important factor in the reported decline of House Sparrow populations in urban areas (Wotton et al., 2002; Summers-Smith, 2003). Short-term exposure of pulsed mobile phone radiation with carrier frequency 900 MHz resulted in a 50-60 % decrease of the reproductive capacity of insects (Panagopoulos et al., 2004). Similar results were also found with microwave radiation at other frequencies (Bol'shakov et al., 2001; Atli and Unlu, 2006).

The results of our study suggest that long-term exposure to low-intensity (pulsed) electromagnetic radiation from GSM base stations may have significant effects on populations of wild birds. The exact mechanisms of these effects are as yet poorly understood. Given the potential importance that such effects may have on aspects of biodiversity and human health, more detailed studies in both the laboratory and the field are urgently needed to corroborate our results and to uncover the underpinning mechanistic relationships.

References

Abdel-Rassoul, G., Abou El-Fatech, O., Abou Salem, M., Michael, A., Farahat, F., El-Batanouny, M., Salem, E. (2006). Neurobehavioral effects among inhabitants around mobile phone base stations. *Neurotoxicology*. DOI: 10.1016/j.neuro.2006.07.012.

Adey, W.R. (1981). Tissue interactions with non-ionizing electromagnetic fields. *Physiol. Rev.* 61:435-514.

Atli, E., Unlu, H. (2006). The effects of microwave frequency electromagnetic fields on the development of Drosophila melanogaster. *Int. J. Radiat. Biol.* 82:435-441.

Balmori, A. (2005). Possible effects of electromagnetic fields from phone masts on a population of White Stork (*Ciconia ciconia*). *Electromagn. Biol. Med.* 24:109-119.

Beasond, R.C., Semm, P. (2002). Responses of neurons to an amplitude modulated microwave stimulas. *Neurosci. Lett.* 333:175-178.

Belyaev, I.Y. (2005a). Non-thermal Biological Effects of Microwaves. *Microwave Review* 11:13-29.

Belyaev, I.Y. (2005b). Nonthermal Biological Effects of Microwaves: Current Knowledge, Further Perspective, and Urgent Needs. *Electromagn. Biol. Med.* 24:375-403.

Bernhardt, J.H. (1992). Non-ionizing radiation safety: radiofrequency radiation, electric and magnetic fields. *Phys. Med. Biol.* 37:80-84.

Bibby, C.J., Burgess, N.D., Hill, D.A., Mustoe, S.H. (2000): *Bird Census Techniques*. London: Academic Press.

Bigu-del-Blanco, J., Romero-Sierra, C. (1975a). The properties of bird feathers as converse piezoelectric transducers and as receptors of microwave radiation. I. Bird feathers as converse piezoelectric transducers. *Biotelemetry* 2:341-353.

Bigu-del-Blanco, J., Romero-Sierra, C. (1975b). The properties of bird feathers as converse piezoelectric transducers and as receptors of microwave radiation. II. Bird feathers as dielectric receptors of microwave radiation. *Biotelemetry* 2:354-364.

Bol'shakov, M.A., Kniazeva, I.R., Lindt, T.A., Evdokimov, E.V. (2001). Effect of low-frequency pulse-modulated 460 MHz electromagnetic irradiation on Drosophila embryos (article in Russian). *Radiats. Biol. Radioecol.* 41:399-402.

Bortkiewicz, A., Zmyslony, M., Szyjkowska, A., Gadzicka, E. (2004). Subjective symptoms reported by people living in the vicinity of cellular phone base stations. *Med. Pr.* 55:345-351.

D'Andrea, J.A., DeWitt, J.R., Emmerson, R.Y., Bailey, C., Stensaas, S., Gandhi, O.P. (1986a). Intermittent exposure of rats to 2450 MHz microwaves at 2.5 mW/cm²: behavioral and physiological effects. *Bioelectromagnetics* 7:315-328.

D'Andrea, J.A., DeWitt, J.R., Gandhi, O.P., Stensaas, S., Lords, J.L., Nielson, H.C. (1986b). Behavioral and physiological effects of chronic 2450 MHz microwave irradiation of the rat at 0.5 mW/cm². *Bioelectromagnetics* 7:45-56.

Eger, H., Hagen, K.U., Lucas, B., Vogel, P., Voit, H. (2004). Influence of the spatial proximity of mobile phone base stations on cancer rates (article in German). *Umwelt-Medizin-Gesellschaft* 17:273-356.

Electronic Communications Committee (2003): *Measuring non-ionising electromagnetic radiation (9 kHz – 300 GHz). Recommendation adopted by the Working Group "Frequency Management" (FM).* Electronic Communications Committee (ECC) within the European Conference of Postal and Telecommunications Administrations (CEPT). ECC/REC/(02)04.

Farrel, J.M., Litovitz, T.L., Penafiel, M. (1997). The effect of pulsed and sinusoidal magnetic fields on the morphology of developing chick embryos. *Bioelectromagnetics* 18:431-438.

Fernie, K.J., Reynolds, S.J. (2005). The effects of electromagnetic fields from power lines on avian reproductive biology and physiology: a review. *J. Toxicol. Environ. Health B Crit. Rev.* 8:127-140.

Grigor'ev, O.A., Bicheldei, E.P., Merkulo, A.V. (2003). Anthropogenic EMF effects on the condition and function of natural ecosystems (article in Russian). *Radiats. Biol. Radioecol* 43:544-551.

Grigoriew, J.G. (2003). The influence of electromagnetic fields from mobile phones on chicken embyo's (article in German). *Journal für Strahlungs-Biologie* 5:541-544.

Hustings, F., Kwak, R., Opdam, P., Reijnen, M. (1985): *Manual bird census work: techniques. backgrounds, guidelines and reporting. Nature conservation in the Netherlands, vol. III* (publication in Dutch). Zeist: Pudoc, Wageningen & Nederlandse Vereniging tot Bescherming van Vogels.

Hutter, H.P., Moshammer, H., Wallner, P., Kundi, M. (2006). Subjective symptoms, sleeping problems, and cognitive performance in subjects living near mobile phone base stations. *Occup. Environ. Med.* 63:307-313

Hyland, G.J. (2000). Physics and biology of mobile telephony. *The Lancet* 356:1833-1836.

Kirschvink, J.L. (1996). Microwave absorption by magnetite: a possible mechanism for coupling nonthermal levels of radiation to biological systems. *Bioelectromagnetics* 17:187-194.

Lai, H. (2005). Biological effects of radiofrequency electromagnetic field. *Encyclopedia of Biomaterials and Biomedical Engineering*. DOI: 10.1081/E-EBBE-120041846.

Liboff, A.R., Jenrow, K.A. (2000). New model for the avian magnetic compass. *Bioelectromagnetics* 21:555-565.

Mouritsen, H., Ritz, T. (2005). Magnetoreception and its use in bird navigation. *Curr. Opin. Neurobiol.* 15:406-414.

Muheim, R., Moore, F.R., Phillips, J.B. (2006). Calibration of magnetic and celestial compass cues in migratory birds – a review of cue-conflict experiments. *J. Exp. Biol.* 209:2-17.

Navarro, E.A., Segura, J., Portolés, M., Gómez-Perretta de Mateo, C. (2003). The Microwave Syndrome: A Preliminary Study in Spain. *Electromagn. Biol. Med.* 22:161-169.

Panagopoulos, D.J., Karabarbounis, A., Margaritis, L.H. (2004). Effect of GSM 900-MHz mobile phone radiation on the reproductive capacity of Drosophila melanogaster. *Electromagn. Biol. Med.* 23:29-43.

Ritz, T., Thalau, P., Phillips, J.B., Wiltschko, R., Wiltschko, W. (2004). Resonance effects indicate radical pair mechanism for avian magnetic compass. *Nature* 429:177-180.

Romero-Sierra, C., Husband, C., Tanner, J.A. (1969): *Effects of microwave radiation on Parakeets in flight.* Ottowa: Control Systems Laboratory.

Santini, R., Santini, P., Danze, J.M., Le Ruz, P., Seigne, M. (2002). Study of the health of people living in the vicinity of mobile phone base stations: I. Influences of distance and sex. *Pathol. Biol.* 50:369-373.

Summers-Smith, J.D. (2003). The decline of the House Sparrow: a review. *Brit. Birds* 96:439-446.

Tanner, J.A. (1966). Effect of microwave radiation on birds. *Nature* 210:636.

Tanner, J.A., Romero-Sierra, C., Davie, S.J. (1967). Non-thermal effects of microwave radiation on birds. *Nature* 216:1139.

Thalau, P., Ritz, T., Stapput, K., Wiltschko, R., Wiltschko, W. (2005). Magnetic compass orientation of migratory birds in the presence of a 1.315 MHz oscillating field. *Naturwissenschaften* 92:86-90.

Van Dijk, A.J. (2004): *Manual for the breeding-bird monitoring project* (publication in Dutch). Beek-Ubbergen: SOVON Vogelonderzoek Nederland.

Wasserman, F.E., Dowd, C., Schlinger, B.A., Byman, D., Battista, S.P., Kunz, T.H. (1984). The effects of microwave radiation on avian dominance behavior. *Bioelectromagnetics* 5:331-339.

Wiltschko, W., Wiltschko, R. (2005). Magnetic orientation and magnetoreception in birds and other animals. *J. Comp. Physiol. A Neuroethol. Sens. Neural. Behav. Physiol.* 191:675-693.

Wolf, R., Wolf, D. (2004). Increased incidence of cancer near a cellphone transmitter station. *Int. J. Cancer Prev.* 1:123-128

Wotton, S.R., Field, R., Langston, R.H.W., Gibbons, D.W. (2002). Homes for birds: the use of houses for nesting by birds in the UK. *Brit. Birds* 95:586-592.

Youbicier-Simo, B.J., Bastide, M. (1999). Pathological effects induced by embryonic and postnatal exposure to EMFs radiation by cellular mobile phones. *Radiat. Protect.* 1:218-223.

EXHIBIT
JJ 6

Electromagnetic Biology and Medicine, 24: 109–119, 2005
Copyright © Taylor & Francis, Inc.
ISSN 1536-8378 print
DOI: 10.1080/15368370500205472

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Possible Effects of Electromagnetic Fields from Phone Masts on a Population of White Stork (*Ciconia ciconia*)

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Monitoring of a white stork population in Valladolid (Spain) in the vicinity of Cellular Phone Base Stations was carried out, with the objective of detecting possible effects. The total productivity, in the nests located within 200 meters of antennae, was 0.86 ± 0.16. *For those located further than 300 m, the result was practically doubled, with an average of* 1.6 ± 0.14. *Very significant differences among the total productivity were found* ($U = 240$; $p = 0.001$, *Mann-Whitney test). In partial productivity, an average of* 1.44 ± 0.16 *was obtained for the first group (within 200 m of antennae) and of* 1.65 ± 0.13 *for the second (further than 300 m of antennae), respectively. The difference between both groups of nests in this case were not statistically significant* ($U = 216$; $P = 0.26$, *Mann-Whitney Test U). Twelve nests (40%) located within than 200 m of antennae never had chicks, while only one (3.3%) located further than 300 m had no chicks. The electric field intensity was higher on nests within 200 m* (2.36 ± 0.82 *V/m) than on nests further than 300 m* (0.53 ± 0.82 *V/m). Interesting behavioral observations of the white stork nesting sites located within 100 m of one or several cellsite antennae were carried out. These results are compatible with the possibility that microwaves are interfering with the reproduction of white storks and would corroborate the results of laboratory research by other authors.*

Keywords Cellsites; Cellular phone masts; *Ciconia ciconia*; Electromagnetic fields; Microwaves; Nonthermal effects; Reproduction; White stork.

Introduction

Most of the attention on the possible biological effects of electromagnetic fields (EMF) has been focused on human health. People frequently use wildlife as biological indicators to detect the alterations in the ecosystems and in an urban

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habitat. The numeric tendency of the populations of birds is of particular interest in the conservation of nature [1].

The cellsite antennae emit a frequency of 900 or 1800 MHz, pulsed in very low frequencies, generally known as microwaves (300 MHz–300 GHz), similar to the radar spectrum. The cellsite ordinarily have 3 sectors, with 3 antennae that cover an angle of 120 degrees each [2–5]. Though they have many and varied outputs, at a distance of 50 m, the power density is about $10\,\mu W/cm^2$ [2], while at distances of 100 m at ground level it measures above $1\,\mu W/cm^2$ (personal observation). Between 150 and 200 m, the power density of the main lobe near the ground is typically of some tenth of $1\,\mu W/cm^2$ [3].

In real life, living organisms are exposed to variable levels of electromagnetic fields (radiofrequencies), according to the distance from the cellular bases stations, the presence of passive structures to either amplify the waves (e.g., the metallic structures) or to shield them (buildings or other obstacles), the number of transmission calls within the transmitters and their position with relationship to the orientation of the antenna [2].

Animals are very sensitive electrochemical complexes that communicate with their environment through electrical impulses. Ionic currents and electric potential differences exist through the cellular membranes and corporal fluids [6]. The intrinsic electromagnetic fields from the biological structures are characterized by certain specific frequencies that can be interfered with by the electromagnetic radiation, through induction and causing modification in their biological responses [3]. Animals exposed to the EMF can suffer a deterioration of health, changes in behavior [7, 8], and changes in reproductive success [9, 10].

The low intensity pulsed microwave radiation from cellsites produces subtle athermal influences in the living organisms, because this radiation is able to produce biological responses by the microwave carrier and by the low frequency of pulses from GSM system. "Windows" exist in whereby EMFs produce biological effects at specific frequencies (window effect) [11]. Some effects are manifested exclusively with a certain power density [12], while others are manifested after a certain duration of the irradiation, which indicates long-term cumulative effects [13]. During lingering exposure, the effects can change from stimulant to inhibition, depending on the pulse shape [14, 15], the duration, development, and differentiation and the physiologic condition or health of the receiving organism [16], and their genetic predisposition [17]. These waves seem to cause different, and even contrary effects, depending on their frequency, intensity, modulation, pulses or time of exposure [12, 16, 18]. The pulsed waves (in bursts) and certain low frequency modulations, produce great biological activity [14, 15, 18]. The dose-response relationships (athermal) are nonlinear [19].

Research has shown such effects on the living organisms at molecular [12] and cellular levels [20] on immune processes [21], in DNA [22], on the nervous, cardiac, endocrine, immune, and reproductive systems [16, 23–28], modification of sleep and alteration of the cerebral electric response (EEG) [29], increase of the arterial pressure and changes in the heart rhythm [30], and an increase in the permeability of the blood brain barrier [31].

The objective of this study was to investigate if the phone mast cellsites caused effects in wild birds similar to the laboratory studies, and studies carried out on people exposed to this radiation [3, 5, 32–35].

Materials and Methods

For monitoring the breeding success of the white stork population, nests ($n = 60$) were selected and visited from May to June of 2003. The difficulty of the investigation in the field, (and when studying wild species) does not allow one to control all variables as in the laboratory; however, the selected nests had similar characteristics. They were located in the roof of churches and buildings inside urban nuclei in Valladolid (Spain). (The nests on trees and other natural supports or outside the urban nuclei were never studied.) Since the cellsite radiations are omnipresent, very few places exist with an intensity of 0 V/m near inhabited nuclei. For that reason, nests were chosen that were exposed at very high or very low levels of electromagnetic radiation, depending on the distance from the nests to the antennas.

The nests were selected and separated in two categories:

a) Nests ($n = 30$) located within 200 m of one or several cellsite antennae (GSM-900 MHz and DCS-1800 MHz), placed in masts and in the roof of the buildings at 15–30 m high.
b) Nests ($n = 30$) located further than 300 m of any cellsites.

The nest were observed using a prismatic Zeiss 8 × 30 and a "Leika" 20-60 X telescope. The number of young were counted.

For the analysis of the results of the reproduction, two indexes were used:

1) the total productivity (number of young flown by each couple, including nests with zero chicks).
2) the partial productivity (number of young flown by couples with some chicks, excluding nests with zero chicks).

To compare the breeding success of both groups of nests a nonparametric test was applied (Mann-Whitney test U).

Also, we measured the electric field intensity (radiofrequencies and microwaves) in V/m, using a "Nuova Elettronica" device Model LX 1435 with 10% sensitivity, from a unidirectional antenna (range: 1 MHz–3 GHz). Keeping in mind the inaccessibility of the nests, the measurements were made in their vacinity under similar conditions, recording the reproducible values obtained when directing the antenna of the device toward the cellsite antenna in line of sight.

Between February 2003 and June 2004, we carried out 15 and 10 visits, respectively, to 20 nests located within 100 m of one or several cellsite antennae to observe the behavior of the species. The visits covered all the phases of breeding, from construction of the nest, until the appearance of young storks exercising their wings and practicing flight.

Results

Table 1 presents the number of young and electric field intensity (V/m) of each studied nest.

The total productivity, in the nests located within 200 m of antennae was 0.86 ± 0.16. For those located further than 300 m, the result was practically doubled, with an average of 1.6 ± 0.14 (Table 1). Both groups showed very significant differences in the breeding success ($U = 240$; $P = 0.001$, Mann-Whitney Test U).

Table 1
Intensity of electric field, total and partial productivity in the nests within 200 m and further than 300 m to the phone mast

Nests within 200 m			Nests further than 300 m		
Nest	Number of young	EMF (V/m)	Nest	Number of young	EMF (V/m)
1	2	0.8	1	1	0.4
2	2	0.6	2	2	0.7
3	0	0.8	3	1	1.3
4	3	1.5	4	1	1.1
5	1	1.7	5	1	0.6
6	2	2.9	6	3	0.4
7	1	3.1	7	2	0.6
8	1	1.3	8	2	0.7
9	1	1.3	9	3	0.6
10	1	2.8	10	1	0.7
11	1	1.8	11	2	0.8
12	3	3.2	12	2	0.3
13	1	1.6	13	3	0.1
14	0	2.7	14	1	0.6
15	0	2.3	15	2	0.5
16	0	2.7	16	3	0
17	0	2.5	17	2	0.3
18	0	3.5	18	1	0.8
19	0	3.5	19	2	0.2
20	0	2.7	20	0	0.8
21	0	2.9	21	2	0.2
22	2	3.2	22	1	0.6
23	0	2.5	23	1	0.5
24	1	2.6	24	1	0.7
25	1	2.4	25	1	1.4
26	0	2.2	26	2	0.1
27	1	2.6	27	1	0.1
28	1	3.1	28	2	0.2
29	1	3.1	29	1	0
30	0	3.0	30	1	0.6
Mean EMF		2.36			0.53
Total productivity		0.86		1.6	
Partial productivity		1.44		1.65	
Nests without young		12 (40%)		1 (3.3%)	

In partial productivity in average of 1.44 ± 0.16 was obtained for the first group (within 200 m of antennae) and 1.65 ± 0.13 for the second (further than 300 m of antennae) respectively. The difference between both groups of nests in this case was not statistically significant ($U = 216$; $P = 0.26$, Mann-Whitney Test U).

Twelve nests (40%) located within 200 m of the antennae never had any chicks, while only one (3.3%), located further than 300 m, never had chicks.

The electric field intensity was higher on nests within 200 m ($2.36 \pm 0.82\,V/m$) that on nests further 300 m ($0.53 \pm 0.82\,V/m$) (Table 1).

The results of the findings and interesting behavioral observations of the white stork nesting sites located within 100 m of one or several cellsite antennae and on those that the main beam impacted directly (EFI > 2 V/m) included young that died from unknown causes. Also, within this distance, couples frequently fought over the nest construction sticks and failed to advance the construction of the nests. (Sticks fell to the ground while the couple tried to build the nest.) Some nests were never completed and the storks remained passively in front of cellsite antennae.

Discussion

The effects of athermal microwaves on birds have been well known for more than 35 years [36, 37]. Some authors obtained beneficial effects in the production of insect eggs and exposed birds, but found that the mortality was doubled [38]. In hen experiments, problems of health and a deterioration of the plumage arose, while in the autopsies, leucosis and tumors of the central nervous system appears [39]. Giarola and Krueger [40] obtained a large reduction of the rate of growth and also a reduction of the adrenal glands, in exposed chickens. Kondra et al. [41] obtained an increase in the frequency of ovulation of exposed birds, and a bigger production of eggs but with less weight, proposing that the pituitary gland was stimulated. Other authors also have obtained effects reducing the rate of growth in chickens and rats, reduction in the production of eggs in hens exposed to microwaves of different frequencies and intensities, increase of fertility, and a deterioration of the quality of the eggshell at certain frequencies [42]. An increase in the embryonic mortality of chickens also has been found [15, 17, 43, 44]. These microwave effects are athermal [45]. Recently, it also has been demonstrated that the microwaves used in cellphones produce an athermal response in several types of neurons of the nervous system in birds [46] and that they can affect the blood brain barrier as has been observed in rats [47].

Birds are especially sensitive to the magnetic fields [48]. The white stork (*Ciconia ciconia*) build their nests on pinnacles and other very high places with high electromagnetic contamination (exposed to the microwaves). Also, they usually live inside the urban environment, where the electromagnetic contamination is higher, and remain in the nest a lot of the time, for this reason the decrease on the brood can be a good biological indicator to detect the effects of these radiations.

The results indicate a difference in total productivity but not in partial productivity between the near nests and those far from the antennae. This indicate the existence of nests without chicks, or the death of young in their first stages in the nests near cellsites (40% of nest without young, compared to 3.3% in nests further 300 m). Also, in the monitoring of the nests near to cellsite antennae, some dead young were observed and several couples never built the nest.

In previous studies in Valladolid, the results of productivity were generally higher than those obtained in this study and less nests appeared without young (Table 2).

Consistent with these results, the microwaves could be affecting one or several reproductive stages: the construction of the nest, the number of eggs, the embryonic

Table 2
Results of censuses carried out in Valladolid (Spain).

Year	Number of visited nests	Total productivity	Partial productivity	Couples without young(%)	References
1984	113	1.69	2.13	7	[65]
1992	115		1.93	5.2	[62]
1994	24	1.84		7.6	[63]
2001	35		2.43		[64]
2003 (<200 m)	30	0.83	1.44	40	This study
2003 (>300 m)	30	1.6	1.65	3.3	This study

development, the hatching or the mortality of chicks in their first stages. The faithfulness of the white stork to nest sites can increase the effects of the microwaves. A Greek study [49] relates to a progressive drop in the number of births of rodents. The mice exposed to 0.168 $\mu W/cm^2$ become sterile after 5 generations, while those exposed to 1.053 $\mu W/cm^2$ became sterile after only 3 generations. The interaction seems to take place through the central nervous system more than on the reproductive gland directly. Other studies find a decrease of fertility, increase of deaths after the birth in rats and dystrophic changes in their reproductive organs [16]. A recent study shows a statistically significant high mortality rate of chicken embryos subjected to the radiation from a cellphone, compared to the control group [43]. EMF exposure affected the reproductive success of kestrels (*Falco sparverius*), increasing fertility, egg size, embryonic development and fledging success but reduced hatching success [10]. An increase in the mortality [50] and the appearance of morphological abnormalities, especially of the neural tube [14, 15, 17] has been recorded in chicken embryos exposed to pulsed magnetic fields, with different susceptibility among individuals probably for genetic reasons. It is probable that each species, even each individual, shows different susceptibility to the radiation, since the susceptibility depends on the genetic bias, and of the irradiated living organisms physiologic and neurological state [4, 51]. Different susceptibility of each species also has been proven in wild birds exposed to CEM from high-voltage powerlines [9]. When the experimental conditions (power density, frequency, duration, composition of the tissue irradiated, etc.) change, their biological effects also change [25, 52]. Microwaves have the potential to induce adverse reactions in the health of people [2–5, 34, 35, 47]. Although the power output differs per site and type of transmitter, at more than 300 m distance from the antennas, most of the symptoms recorded in people diminish or disappear [34, 35]. It also has been pointed out that below 0.6 V/m the effects on the people disappear (Salzburg resolution).

Since, we cannot see symptoms for white storks, it is necessary to use objective variables such as the Total and Partial Productivity, and other characteristics of behavior (nonconstruction of nest, sticks fall, etc.). We recommend electromagnetic contamination in the microwave range be considered a risk factor in the decline of some populations, especially urban birds, especially when exposed to higher radiation levels. Because of their thinner skull, their great mobility and the fact that they use areas with high levels of microwave electromagnetic radiation, birds are very good biological indicators. The freedom of movement of birds and their habit of settling in the proximity and even on the cellsites, makes them potentially susceptible to such effects. Small organisms (children, birds, small mammals, etc.) are especially vulnerable, as absorption of microwaves of the frequency used in mobile telephones is greater as a consequence of the thinner skull of a bird, the penetration of the radiation into the brain is greater [2, 49, 53, 54].

Several million birds of 230 species die annually from collisions with the masts of telecommunication facilities in United States during migration [55]. The cause of the accidents has yet to be proven, although one knows that they mainly take place during the night, in fog, or bad weather. The birds use several orientation systems: the stars, the sun, the site-specific recognition and the geomagnetic field [48]. The illumination of the towers probably attracts the birds in the darkness, but it is possible that the accidents take place in circumstances of little visibility, because at the time, other navigational tools are not available. The perception to the terrestrial magnetic field can be altered by the electromagnetic radiation from the antennae. The reports of carrier pigeons losing direction in the vicinity of cellsites are numerous, and more investigation is necessary.

In the United Kingdom, where the allowed radiation levels are 20 times higher than those of Spain, a decline of several species of urban birds has recently taken place [56], coinciding with the increasing installations of cellsites. Although this type of contamination is considered at the present time by some experts as the most serious [4], inspection systems and controls have never been developed to avoid their pernicious effects on living organisms. Some of the biological mechanisms of the effects of these waves are still ignored [12], although the athermal effects on organisms have been sufficiently documented. The telephone industry could be taking advantage of the complexity of the biological and physical processes implied, to create an innocuous atmosphere, repeatedly denying the existence of harmful effects in living organisms. For this reason the reports related to animals are of special value, since in this case it can never be alleged that the effects are psychosomatic [3].

Future investigation should be carried out with long-term monitoring of the breeding success, of the sleeping places and of the uses of the habitat for species more vulnerable to the microwaves. Of special interest should be investigations that try to make correlations with the radiofrequency electromagnetic field measurements. Field studies investigating populations of urban parks and territories surrounding cellsites should be a high-priority. A radius of 1 sq K and the layout of concentric lines at intermediate distances can be useful to investigate differential results among areas depending on their vicinity and the radiation levels. We consider that the birds most affected from the microwave electromagnetic contamination could be:

1) those bound to urban environments with more sedentary customs, in general those that spend more time in the vicinity of the base stations;
2) those that live or breed in high places, more exposed to the radiation and at higher power density levels;
3) those that breed on open structures where the radiation impacts directly on adults and chicks in the nest;
4) those that spend the night outside of holes or structures that attenuate the radiation.

In far away areas, where the radiation decreases progressively, the chronic exposure can also have long term effects [13, 49]. Effects from antennas on the habitat of birds are difficult to quantify, but they can cause a serious deterioration, generating silent areas without male singers or reproductive couples. The deterioration of the ecosystem can also take place from the impact of the radiation on the populations of invertebrate prey [54, 57, 58] and on the plants [59].

Bioelectromagnetics is historically a frontier discipline. Controversy is frequent when the scientists recognize serious effects on health and on the environment that cause high economic losses. Independent investigators state the necessity of a drastic reduction of the emmitted power levels on people and the ecosystems and that it is technically viable although more expensive for the industry [4, 22, 60]. Our opinion is that areas of continuous use should never exist at the height of the antennas either inside the beam or within a radius of several hundreds meters. The restriction to exposure to fauna presents special complexity; the main reason for the drastic reduction in the emission power of the antennae is presented as the only viable and effective solution to prevent these effects. Some authors have already propose that we are withessing a paradigm change in biology [61].

Acknowledgment

Thanks are due to Denise Ward revised the English translation of the text and to Manuel González, for his company in the visit to San Pablo. Juan Matute and José Antonio García provided the information of some white stork censuses carried out in Valladolid. The CDA (Junta de Castilla y León) helped me efficiently in obtaining some of the papers. Comments by an anonymous referee greatly improved the manuscript.

References

1. Bibby, C.J.; Burgess, N.D.; Hill, D.A. Bird Census Techniques. BTO and RSPB.
2. Santini, R.; Seigne, M.; Bonhomme-Faibre, L. Danger des téléphones cellulaires et de leurs stations relais. Pathol. Biol. **2000**, *48*, 525–528.
3. Hyland, G.J. Physics and biology of mobile telephony. Lancet **2000**, *356*, 1–8.
4. Hyland, G.J. *The physiological and environmental effects of non-ionising electromagnetic radiation*. Working document for the STOA Panel. European Parliament. Directorate General for Research. 2001.
5. Navarro, E.A.; Segura, J.; Portolés, M.; Gómez Perretta, C. The microwave syndrome: a preliminary study in Spain. Electromag. Biol. Med. **2003**, *22*, 161–169.
6. Heredia-Rojas, L.; Rodríguez-Flores, M.; Santoyo-Stephano, E.; CastaÑeda Garza, A.; Rodríguez-De La Fuente. Los campos electromagnéticos: Un problema de salud pública? Respyn. **2003**, *4*, 1–10.
7. Marks, T.A.; Ratke, C.C.; English, W.O. Stray voltage and developmental, reproductive and other toxicology problems in dogs, cats and cows: a discusion. Vet. Hum. Toxicol. **1995**, *37*, 163–172.

   Monteagudo, J.L. Bioelectromagenetismo y salud pública efectos, prevención y tratamiento, Bardasano J.L. IBASC Alcala de Henares, 1997; 201–210.
8. Löscher, W.; Käs, G. Conspicuous behavioural abnormalities in a dairy cow herd near a tv and radio transmitting antenna. Pract. Vet. Surg. **1998**, *29*, 437–444.
9. Doherty, P.F.; Grubb, T.C. Effects of high-voltage power lines on birds breeding within the power lines' electromagnetic fields. Sialia **1996**, *18*, 129–134.

10. Fernie, K.J.; Bird, D.M.; Dawson, R.D.; Lague, P.C. Effects of electromagnetic fields on the reproductive success of American kestrels. Physiol. Biochem. Zool. **2000**, *73* (1), 60–65.
11. Adey, W.R. Tissue interactions with non-ionizing electromagnetic fields. Physiol. Rev. **1981**, *61*, 435–514.
12. Daniells, C.; Duce, I.; Thomas, D.; Sewell, P.; Tattersall, J., De Pomerai, D. Transgenic nematodes as biomonitors of microwave-induced stress. Mutat. Res. **1998**, *399*, 55–64.
13. Adey, W.R. Bioeffects of mobile communications fields: possible mechanisms for cumulative dose. In *Mobile Communication Safety*; Kuster, Balzano, Lin, Eds.; London: Chapman and Hall, 1996; 95–131.
14. Ubeda, A.J.; Leal, M.A.; Trillo, M.A.; Jimenez, M.A.; Delgado, J.M.R. Pulse shape of magnetic fields influences chick embryogenesis. J. Anat. **1983**, *137*, 513–536.
15. Ubeda, A.; Trillo, M.A.; Chacon, L.; Blanco, M.J. Leal, J. Chick embryo development can be irreversibly altered by early exposure to weak extremely-low-frequency magnetic fields. Bioelectromagnetics **1994**, *15*, 385–398.
16. Nikolaevich, N.; Igorevna, A.; Vasil, G. Influence of high-frequency electromagnetic radiation at non-thermal intensities on the human Body (a review of work by Russian and Ukrainian researchers). No Place to Hide **2001**, *3*, Suppl.
17. Farrel, J.M.; Litovitz, T.L.; Penafiel, M. The effect of pulsed and sinusoidal magnetic fields on the morphology of developing chick embryos. Bioelectromagnetics **1997**, *18*, 431–438.
18. Grigoriew, Ju. G. Role of modulation in biological effects of electromagnetic radiation. Radiat. Biol. Radioecol. **1996**, *36*, 659–670.
19. Marino, A.A.; Nilsen, E.; Frilot, C. Nonlinear changes in brain electrical activity due to cell phone radiation. Bioelectromagnetics **2003**, *24*, 339–346.
20. Dutta, S.K.; Ghosh, B.; Blackman, C.F. Radiofrequency radiation-induced calcium ion efflux enhancement from human and other neuroblastoma cells in culture. Bioelectromagnetics **1989**, *10*, 197–202.
21. Obukhan, K.I. The effect of ultrahigh-frequency radiation on adaptation thresholds and the damages to blood system cells. Lik Sprava **1998**, *7*, 71–73.
22. Sarkar, S.; Ali, S.; Behari, J. Effect of low power microwave on the mouse genome: a direct DNA analysis. Mutat. Res. **1994**, *320*, 141–147.
23. Grigoriew, Ju. G.; Luk'ianova, S.N.; Makarov, V.P.; Rynskov, V.V. Total bioelectric activity of various structures of the brain in low-intensity microwave irradiation. Radiat. Biol. Radioecol. **1995**, *35*, 57–65.
24. Altpeter, E.S.; Krebs, Th.; Pfluger, D.H.; von Kanel, J.; Blattmann, R. Study of health effects of Shortwave Transmitter Station of Schwarzenburg, Berne, Switzerland. University of Berne, Institute for Social and Preventative Medicine, 1995.
25. Dasdag, S.; Ketani, M.A.; Akdag, Z.; Ersay, A.R.; Sar, I.; Demirtas, Ö.C.; Celik, M.S. Whole body microwave exposure emitted by cellular phones and testicular function of rats. Urolog. Res. **1999**, *27*, 219–223.
26. Belousova, T.E.; Kargina-Terent'eva, R.A. Adrenergic nerve plexuses of heart and adrenal and myocardial catecholamines of spontaneously hypertensive rats under the influence of electromagnetic irradiation in the milimeter range. Morfologia **1999**, *115*, 16–18.
27. Kolodynski, A.A.; Kolodynska, V.V. Motor and psychological functions of school children living in the area of the Skrunda radio location station in Latvia. Sci. Total Environ. **1996**, *180*, 87–93.
28. Petrides, M. Exposure to electromagnetic fields by using cellular telephones and its influence on the brain. Neuroreport **2000**, *15*, F15.
29. Mann, K.; Roschkle, J. Effects of pulsed high-frequency electromagnetic fields on human sleep. Neuropsychobiol. **1996**, *33*, 41–47.

30. Szmigielski, S.; Bortkiewicz, A.; Gadzicka, E.; Zmyslony, M.; Kubacki, R. Alteration of diurnal rhythms of blood pressure and heart rate to workers exposed to radiofrequency electromagnetic fields. Blood Press. Monit. **1998**, *3*, 323–330.
31. Fritze, K.; Sommer, C.; Schmitz, B.; Mies, G.; Hossman, K.; Kiessling, M. Effect of global system for mobile communication (GSM) microwave exposure on blood-brain barrier permeability in rat. Acta Neuropathol. **1997**, *94*, 465–470.
32. Lilienfeld, A.M.; Tonascia, J.; Tonascia, S.; Libauer, C.A.; Cauthen, G.M. Foreign Service Health Status Study—Evaluation of Health Status of Foreign Servic and Other Employees from Selected Eastern European Posts. Final Report; **1978**.
33. Hutter, H.P.; Moshammer, H.; Kundi, M. Mobile telephone base-stations: efects on health and wellbeing. 2nd International workshop on biological effects of EMFs. Rhodes (Greece). **2002**, *1*, 344–352.
34. Santini, R.; Santini, P.; Le Ruz, P.; Danze, J.M. Seigne, M. Survey study of people living in the vicinity of cellular phone base. Electromag. Biol. Med. **2003**, *22*, 41–49.
35. Santini, R.; Santini, P.; Danze, J.M.; Le Ruz P.; Seigne, M. Symptoms experienced by people in vicinity of base stations: II/incidences of age, duration of exposure, location of subjects in relation to the antennas and other electromagnetic factors. Pathol. Biol. **2003**, *51*, 412–415.
36. Tanner, J.A. Effect of microwave radiation on birds. Nature **1966**, *210*, 636.
37. Tanner, J.A.; Romero-Sierra, C.; Davie, S.J. Non-thermal effects of microwave radiation on birds. Nature **1967**, *216*, 1139.
38. Tanner, J.A.; Romero-Sierra, C. Beneficial and harmful growth induced by the action of nonionizing radiation. Ann. NY Acad. Sci. **1974**, *238*, 171–175.
39. Tanner, J.A.; Romero-Sierra, C. The effects of chronic exposure to very low intensity microwave radiation on domestic fowl. J. Bioelectr. **1982**, *1*, 195–205.
40. Giarola, A.J.; Krueger, W.F. Continuous exposure of chick and rats to electromagnetic fields. IEEE Trans. Microwave Theory Tech. **1974**, *22*, 432–437.
41. Kondra, P.A.; Smith, W.K.; Hodgson, G.C.; Brag, D.B.; Gavora, J.; Hamid, M.A.; Boulanger, R.J. Growth and reproduction of chickens subjected to microwave radiation. Can. J. Anim. Sci. **1970**, *50*, 639–644.
42. Krueger, W.F.; Giarola, A.J.; Bradley, J.W.; Shrekenhamer, A. Effects of electromagnetic fields on fecundity in the chicken. Ann. NY Acad. Sci. **1975**, *247*, 391–400.
43. Grigoriew, Ju. G. Influence of the electromagnetic field of the mobile phones on chickens embryo, to the evaluation of the dangerousness after the criterion of this mortality. J. Radiat. Biol. **2003**, *5*, 541–544.
44. Youbicier-Simo, B.J.; Lebecq, J.C.; Bastide, M. Mortality of chicken embryos exposed to EMFs from mobile phones. Presented at the Twentieth Annual Meeting of the Bioelectromagnetics Society, St. Petersburg Beach, Florida, June 1998.
45. Van Ummersen, C.A. An Experimental Study of Developmental Abnormalities Induced in the Chick Embryo by Exposure to Radiofrequency Waves. Ph. D. dissertation, Department of Biology, Tufts University, Medford, MA, 1963.
46. Beasond, R.C.; Semm, P. Responses of neurons to an amplitude modulated microwave stimulas. Neurosci. Lett. **2002**, *33*, 175–178.
47. Salford, L.G.; Brun, A.E.; Eberhardt, J.L.; Malmgren, L.; Persson, B.R. Nerve cell damage in mammalian brain after exposure to microwaves from GSM mobile phones. Env. Health Persp. **2003**, *111*, 881–893.
48. Liboff, A.R.; Jenrow, K.A. New model for the avian magnetic compass. Bioelectromagnetics **2000**, *21*, 555–565.
49. Magras, I.N.; Xenos, T.D. Radiation-induced changes in the prenatal development of mice. Bioelectromagnetics. **1997**, *18*, 455–461.
50. Youbicier-Simo, B.J.; Bastide, M. Pathological effects induced by embryonic and postnatal exposure to EMFs radiation by cellular mobile phones. Radiat. Protect. **1999**, *1*, 218–223.

51. Fedrowitz, M.; Kamino, K.; Löscher, W. Significant differences in the effects of magnetic field exposure on 7,12-dimethylbenz(a)anthracene-induced mammary Carcinogenesis in two substrains of Sprague-Dawley rats. Cancer Research **2004**, *64*, 243–25l.
52. Kemerov, S.; Marinkev, M.; Getova, D. Effects of low-intensity electromagnetic fields on behavioral activity of rats. Folia Med. **1999**, *41*, 75–80.
53. Maisch, D. Children and mobile phones ... is there a health risk? The case for extra precautions. J. Australasian Coll. Nutri. Env. Med. **2003**, *22*, 3–8.
54. Balmori, A. Aves y telefonía móvil. Resultados preliminares de los efectos de las ondas electromagnéticas sobre la fauna urbana. El Ecologista **2003**, *36*, 40–42.
55. Shire, G.G.; Brown, K.; Winegrad, G. Communication Towers: A Deadly Hazard To Birds. American Bird Conservancy, 2000.
56. Raven, M.J.; Noble, D.G.; Baillie, S.R. The Breeding Bird Survey 2002. BTO Research Report 334. British Trust for Ornithology, Thetford, 2003.
57. Weisbrot, D.; Lin, H.; Ye, L.; Blank, M.; Goodman, R. Effects of mobile phone radiation on reproduction and development in Drosophila melanogaster. J. Cell. Biochem. **2003**, *89*, 48–55.
58. Panagopoulos, D.J.; Karabarbounis, A.; Margaritis, L.H. Effect of GSM 900-MHz mobile phone radiation on the reproductive capacity of Drosophila melanogaster. Electromag. Biol. Med. **2004**, *23*, 29–43.
59. Balmori, A. ¿Pueden afectar las microondas pulsadas emitidas por las antenas de telefonía a los árboles y otros vegetales?. Ecosistemas **2004**, *3*, 1–10.
    Balode, S. Assessment of radio-frequency electromagnetic radiation by the micronucleus test in bovine peripheral erythrocytes. Sci. Total. Environm. **1996**, *180*, 81–85.
60. De Pomerai, D.; Daniells, C.; David, H.; Allan, J.; Duce, I.; Mutwakil, M.; Thomas, D.; Sewell, P.; Tattersall, J.; Jones, D.; Candido, P. Non-thermal heat-shock response to microwaves, Nature **2000**, *405*, 417–418.
61. Adey, W.R. Electromagnetic fields, the modulation of brain tissue functions—a possible paradigm shift in biology. In *International Encyclopedia of Neuroscience*; Smith, B., Adelman, G., Eds.; New York; 2003.
62. Alauda. Censo de Cigüeña Blanca (*Ciconia ciconia*) en la provincia de Valladolid. Año, 1992.
63. Alauda. Censo de Cigüeña Blanca (*Ciconia ciconia*) en la provincia de Valladolid. Año, 1994.
64. Garcia, J.A. Apuntes sobre la población de Cigüeña Blanca (Ciconia ciconia) en el núcleo urbano de Valladolid.
65. Lázaro, E.; Chozas, P.; Fernández-Cruz, M. Demografía de la Cigüeña blanca (Ciconia ciconia) en España. Censo Nacional de 1984. Ardeola **1986**, *33*, 131–169.

Bioelectromagnetics 18:455–461 (1997)

RF Radiation–Induced Changes in the Prenatal Development of Mice

EXHIBIT
Blumberg No. 5136
IJ 7

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The possible effects of radiofrequency (RF) radiation on prenatal development has been investigated in mice. This study consisted of RF level measurements and in vivo experiments at several places around an "antenna park." At these locations RF power densities between 168 nW/cm^2 and 1053 nW/cm^2 were measured. Twelve pairs of mice, divided in two groups, were placed in locations of different power densities and were repeatedly mated five times. One hundred eighteen newborns were collected. They were measured, weighed, and examined macro- and microscopically. A progressive decrease in the number of newborns per dam was observed, which ended in irreversible infertility. The prenatal development of the newborns, however, evaluated by the crown-rump length, the body weight, and the number of the lumbar, sacral, and coccygeal vertebrae, was improved. *Bioelectromagnetics 18:455–461, 1997.* © 1997 Wiley-Liss, Inc.

Key words: RF radiation effects; prenatal development; mice development

Five years ago the "antenna-park of Thessaloniki" progressively developed on the top of the nearby mountain Chortiatis, 1.5 km away from a small village of the same name. Today, almost 100 commercial TV and FM-radio broadcasting transmitters in the VHF and the UHF bands are situated there. The antennas are installed on towers well visible from a large part of the village. Living so close to the antennae and the vast amount of RF power they transmit, which is of the order of 300 kW, the people of the village Chortiatis, anxious for their health, encouraged the author to undertake a research program.

The hypothesis that RF radiation may adversely affect the health of the animal organism is still under consideration in public and scientific forums. One of the critical issues seems to be the RF effects on the reproductive process [Chernoff et al., 1992]. Numerous studies dealing with this subject ended up with seemingly contradictory results. Therefore, an "in vivo" study on experimental animals sensitive to RF radiation, was chosen. Based on the relevant literature, this research investigated RF radiation effects on the reproductive system, particularly on prenatal development. The mouse was selected as the experimental animal, because it is easily manipulated in the environment in which the experiments had to take place. Of course, experimenting at the mountain sites, far from the easily controlled laboratory conditions, might add a certain amount of uncertainty; therefore, these experiments should be considered preliminary.

MATERIALS AND METHODS

We used a total of 36 mice (18 females and 18 males), 2 months old and sexually mature (BALB/c/f breed colony). Breeding colony virgin males and females were obtained from the "Theageneion Anticancer Institute of Thessaloniki." The use of these experimental animals was approved by the Veterinary Service of the Municipality of Thessaloniki, according to the provisions of the laws 1197/81 and 2015/92 and the Presidential Decree 160/91 of the Greek Democracy. Upon arrival, all experimental animals were quarantined for 2 weeks to discover and to allow them to acclimatise the mountain environment, an altitude ranging between 570 (position h) and 730 m (position d) above sea level. All the mice were healthy at the end of this period and showed no signs of illness during

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Received for review 9 June 1996; revision received 30 January 1997

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TABLE 1. Light–Dark Cycle during the Experimental Matings

Gestation	Date	Day		Night	
		Min	Max	Min	Max
1st	25.5–16.6	14.28	14.47	09.13	09.32
2nd	21.6–12.7	14.37	14.48	09.12	09.23
3rd	6.9–29.9	11.54	12.45	11.15	12.06
4th	7.10–28.10	10.45	11.35	12.25	13.15
5th	23.11–13.12	09.34	09.55	14.05	14.26

the course of the study. Tap water and certified feed (Greek Sugar Factory) were freely available.

The mice were maintained under natural lighting, both during the daytime and at the night (Table 1). Twelve Plexiglas cages transparent to RF radiation, were placed at several locations with one female in each cage. Each female was caged with one male for 12 h. Vaginal smears were taken the next morning and successful mating was identified by the presence of sperm. The day on which evidence of mating was observed was considered to be the first day of gestation. The litters were collected in the first 2 h after delivery and were moved to the laboratory for examination. After a period of recovery, the same mating procedure was repeated for each dam. Five experimental pregnancies were carried out in a period of almost 6 months.

The first pregnancy of the experimental animals took place in eight selected positions (a–h, Fig. 1), some close to the "antenna-park" and some near the village of Chortiatis. Then the experimental animals were moved to two positions, because these positions presented almost the same RF radiation levels with those initially selected and the experiment could be managed more effectively. Six dams (labelled as group A), initially placed at positions a, b, c, and d, with their males, were moved to the position d (Refuge of Hypaithrios Life). The other six dams (labelled group B), with their males, initially placed at positions e, f, g, and h were moved to position h (Public Primary School of Chortiatis). These two positions were selected because the most important living conditions, i.e., light, temperature, ventilation, food, etc., were the same.

Finally, all the experimental animals were moved to position i (Laboratory of Anatomy, School of Veterinary Medicine, University of Thessaloniki) about 10 km away from the Mountain Chortiatis, in the city of Thessaloniki, for the fifth pregnancy. This relocation was done to seek an indication of a possible reversibility of the observed phenomena. In fact, we wanted to repeat the experiment in an environment almost free of RF. An extra group of six couples of mice were mated once and used as controls in the laboratory (posi-

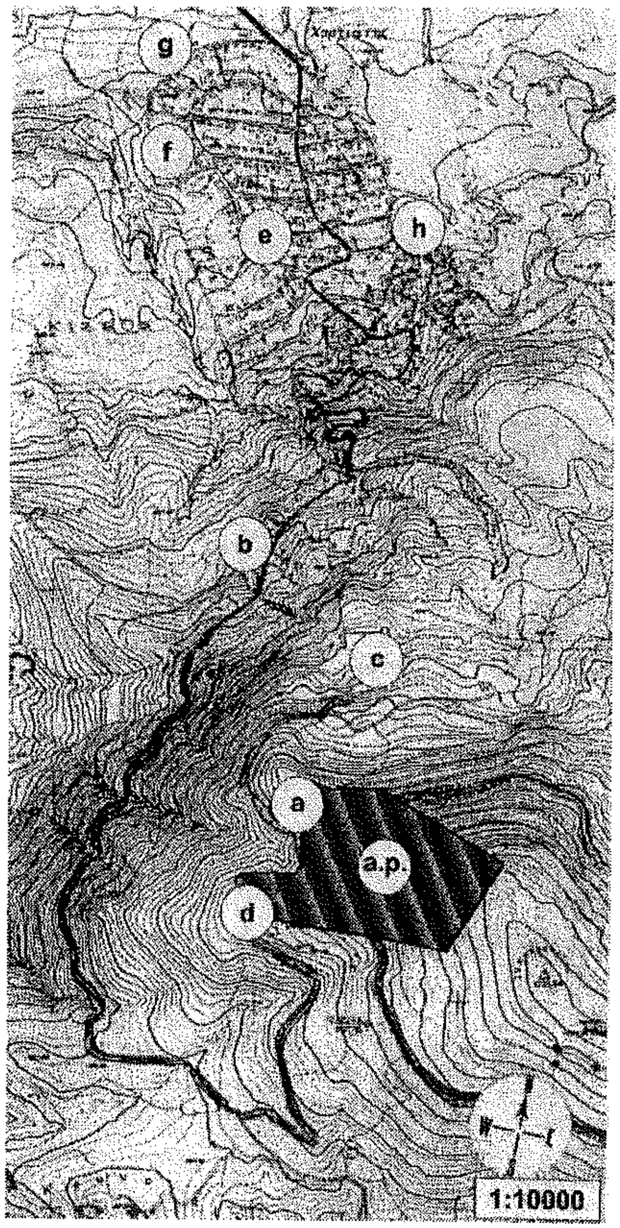

Fig. 1. Wide area of Chortiatis, where the fist four matings took place.

tion i), far from the "antenna park" in a more or less free-of-RF radiation environment.

It was extremely difficult to use RF-free controls at the mountain sites, because it was almost impossible to make "electromagnetically screened cages." Such a cage should ideally provide high (of the order of 30 dB) screening at the frequency range between 88.5 and 950 MHz (Commercial Radio FM band, UHF TV band, and Mobile Communication band), and therefore would require a very dense and well-grounded, highly conductive external metal grid. Obviously, mice could hardly survive in such cages for about 5 months.

The litter was considered to be the experimental unit for the analysis of data. We measured the crown-rump length, the body weight, the number of the posterior (lumbar, sacral, and coccygeal) vertebrae, the congenital malformations, and the ossification of the skeleton.

The RF power was measured in each position, using an electric field meter and a low gain (4 dB) wide-band (80–900 MHz) log-periodic antenna and spectrum analyser. To obtain comparable results the "IEEE std. C95.3.1991" was used. On the third floor of the public school, where the mice were situated, a 360 degree integration was also performed, due to the directivity of the measuring antenna together with the close proximity of the walls and metal furniture. Wherever iron bars or metal screens existed in front of the windows, two series of measurements were carried out; one on each side of the screen.

The collected newborns were killed for examination. Their crown-rump length was measured, and they were weighed and inspected under the dissecting microscope for external congenital malformations. Then they were fixed and subsequently cleared and stained in toto by a double staining of their skeleton [Peters, 1977]. The procedure was lightly modified as follows:

The newborns were fixed with alcohol 86% for 3 days; their skin, eyes, and viscera were removed; then they were immersed for 3 days in alcohol 100% and for 4 days in a mixture of alcohol 100% and ether 1:1. They were stained for 1–2 days with blue alcyan coloration [alcohol 86% 80 ml, acetic acid 20 ml, alcyan blue 20 mg] until the nonmineralised cartilagenous parts of the bones became blue. They were immersed in alcohol 100% for 4 days. Then they were stained for 12–24 days with red alizarin coloration [KOH 1 g, H_2O 100 ml, alizarin solution (alcohol 86% saturated with alizarin red S) 0.1 ml] until the ossified parts of the bones became red. They were immersed in solution Mall I (KOH 1 g, distilled water 80 ml, glycerine 20 ml) until the transparency of their body was completed. Finally, they were stored in a conservation solution (distilled water and glycerine 1:1, with some thymol crystals as contamination prevention). The stained newborns were inspected for skeletal defects as well as for the degree of ossification of their bones. The ossification of the skeleton and particularly of the vertebrae is an excellent and creditable indicator of the prenatal exposure to noxious agents and can be a measure of development delay.

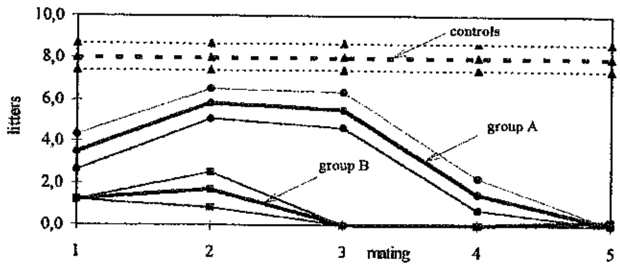

Fig. 2. Comparison of the mean values ± standard deviation of number of newborns per dam and mating from all experimental groups.

RESULTS

The RF power levels measured, although below the limits proposed by the "ENV50166-2" and the "IEEE C95.1.1991" standards, are high and well above the power levels that are likely to be measured in other European or U.S. residential areas. In fact, on the third floor of the public primary school (position h), an average power density of 1.053 $\mu W/cm^2$ was found, equivalent to a specific absorption rate of 1.935 mW/kg. In the Hypaithrios Life Refuge (position d) the average power density in which the mice were located was of the order of 168 nW/cm^2. This reduced level was due to the screening effect of the iron bars in front of the windows, which gave an 8–10 dB RF-power decrease. The average power density levels in position i (Laboratory of Anatomy, School of Veterinary Medicine, University of Thessaloniki), where the controls were placed and the fifth experimental matings were performed, was 40 dB weaker.

The number of the littered newborns by the experimental dams of groups A and B were, compared with those littered by the controls, progressively reduced from the first to the fifth pregnancy. This reduction is more evident in group B and is clearly shown in Table 2 and in Figure 2.

On the other hand, the rest of the four measured parameters, i.e., the crown rump length and the weight and the number of the lumbar, sacral, and coccygeal vertebrae increased in the newborns from groups A and B compared with the controls. This was more evident in group A than in group B (Table 2 and Fig. 3). A

TABLE 2. Statistical Characteristics of All Four Measurable Parameters per Dam, per Group, and per Gestation

Mating	Litters per dam mean ± s.d. median	Length (cm)	Weight (gr)	Vertebrae
Group A (6 dams)				
1st (25.05.1995)	3.5 ± 0.9	1.47 ± 0.13	2.71 ± 0.09	31.48 ± 1.43
	4.0	1.44	2.69	32.07
2nd (21.06.1995)	5.8 ± 0.7	1.25 ± 0.06	2.55 ± 0.05	24.28 ± 0.97
	7.0	1.22	2.50	24.29
3rd (08.09.1995)	5.5 ± 0.9	1.72 ± 0.25	2.71 ± 0.13	28.72 ± 1.92
	6.5	1.72	2.60	28.71
4th (07.10.1995)[a]	1.5	1.10	2.47	23.22
	0.0	1.10	2.47	23.22
5th (23.11.1995)[a]	0.0			
	0.0			
Mean value	3.3	1.39	2.61	26.93
Group B (6 dams)				
1st (25.05.1995)[a]	1.2	1.19	2.53	28.57
	0.0	1.19	2.53	28.57
2nd (21.06.1995)	1.7 ± 0.9	1.25 ± 0.04	2.60 ± 0.06	28.55 ± 1.14
	1.5	1.26	2.58	27.26
3rd (08.09.1995)[a]	0.0			
	0.0			
4th (07.10.1995)[a]	0.0			
	0.0			
5th (23.11.1995)	0.2	1.05	2.50	30.00
	0.0	1.05	2.50	30.00
Mean value	0.6	1.16	2.54	29.04
Controls (6 dams)				
1st (23.11.1995)	8.0 ± 0.07	0.96 ± 0.15	2.38 ± 0.02	19.59 ± 0.47
	7.5	0.97	2.37	19.52
Mean value	8.0	0.96	2.38	19.59

[a]Single or no gestation.

thorough external and internal examination under the dissecting microscope revealed only one case of extensive and two cases of limited malformation. No retardation of skeletal ossification worth mentioning was observed; only five cases out of 116 showed limited retardation. It has to be noted here, that the evaluation of the skeleton ossification was focused in the bones of the forelimbs and hindlimbs and in the lumbar, sacral, and coccygeal vertebrae.

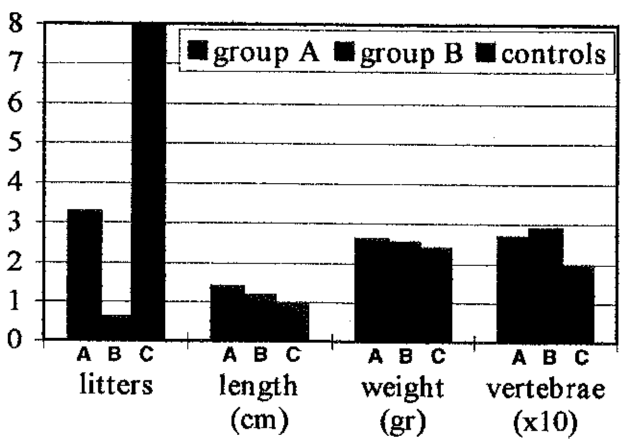

Fig. 3. Comparison of the mean values of all four measurable parameters for all gestations. Controls (C).

DISCUSSION

To study effects of a possibly noxious agent on a mammalian embryo, three groups should be considered: the embryos, the dams, and the males. In this work, all three have been studied: the infertility for dams and males, the lethality for embryos, the teratogenicity or the reduction in deformity for foetuses, or any combinations of them. They all have been considered by exposing male and female mice (before and during pregnancy) to an RF-radiation environment close to the "antenna park."

Infertility and lethality were assessed by counting the number of their newborns, whereas the possible teratogenicity and the reduction deformity by autopsy was considered by the study of the embryonic skeletons. An important stage in this study was the examination of the skeletons, since the ossification of the bones is considered an excellent and creditable indicator of the prenatal exposure to noxious agents and can be a measure of development delay. In the beginning of organogenesis, the neural tube functions as a precursor of the cartilages and bones of the developing skeleton [Noden and Delahunta, 1985]. Teratogenic factors of any kind, that affect the embryonic nervous system, result in structural defects of the skeletal components. Therefore, to detect the teratogenic action of a factor on the embryonic nervous system, it is technically convenient to study the foetal skeleton rather than the embryonic nervous system itself.

A very important result of this experimental study (Table 2 and Fig. 2) is a progressive decrease of the number of the size of the litters of the dams of group A (position d) and group B (position h), compared with the controls (position i) and with the breeding history of these mice. Mice from the BALB/c/f breeding colony obtained from the "Theageneion Anticancer Institute of Thessaloniki" have been used for years in our laboratory for reproduction. Repeated pregnancies with a recovery period of 1–4 weeks for over a year, had never affected the fertility of the dams or any morphological parameters of the offspring, a fact that to our knowledge has not been questioned in the available literature.

It is worth noting that the RF power density levels, although very different from place to place, were very low and well below the CENELEC and IEEE relevant standards. Yet, it should be pointed out that:

(a) the experimental animals lived in this environment for 6 months, which is a long period of time,

(b) there was a considerable difference in power density levels of the order of 10 dB between the two main positions d and h and almost of 40 dB between d and i,

(c) there is a considerable difference between the volumes and consequently the body mass of the adult mouse and other experimental animals used as models in the international standards applied to humans.

The interpretation of our observations could follow various directions. The most popular view in numerous studies of the relevant literature, that this is a consequence of the overheating of the irradiated testis [Lary et al., 1986, 1987; O'Connor, 1980)] could be considered. On the other hand, the assumption that RF and microwave radiation effects are limited to heating has been questioned in a series of studies [Cleary, 1988, 1990]. The exposure conditions in these "in vivo" studies may suggest a thermal component of RF-induced testicular damage. However, interpretation of these data with respect to damage thresholds or interaction mechanisms is difficult. This difficulty is due to a number of factors, including the time, intensity, or both, the variations in species sensitivities, and the frequency-dependent non-uniform microwave energy absorption in tissue. Consequently, although these findings seem to be consistent with a hypothesis that the RF-induced heating is associated with testicular damages, the borderline between the "direct" effects of radiation and the effects that are indirectly associated with the tissue heating is not very clear.

Our observations could also be attributed to an intra-uterus death of the irradiated embryos in the early stages of the prenatal development, a speculation that could not be investigated in our experimental design because it required a postmortem autopsy of the dam. On the other hand, the prerequisite to these scenarios is a large RF power density, whereas the power densities we measured were of the order of $\mu W/cm^2$ or nW/cm^2, rather than mW/cm^2, or in terms of specific absorption rate (SAR), mW/kg rather than W/kg. Therefore, we cannot exclude the possibility of an indirect nonthermal mechanism focused on the endocrinological axon hypophysis-gonads that causes infertility to the males or the females [Thuery, 1991].

It should be noted here that the male experimental animals progressively developed a very bad physiological condition (rough hair, emaciation, etc.), not correlated to any other sickness symptoms, during their stay at the experimental positions a–g. Therefore, despite of the limited amount of data, the duration of the exposure to low intensity RF electromagnetic fields seems to be a repression parameter. In fact, chronic or long-term exposure to low intensity electromagnetic fields is generally associated with adverse results [Lary et al., 1983]. The most peculiar findings of this study were the increases in the crown-rump length, the body weight, and the number of the posterior vertebrae (lumbar, sacral, and coccygeal) of the experimental offsprings compared with the controls (Table 2, Fig. 3).

It must be noted that a study of mice [Jensh et al., 1977; 1978a; 1978b] under low levels of irradiation during the whole period of a single gestation (10 and 20 mW/cm^2) had no effect on maternal, foetal, or placental masses and no effect on the frequency of resorption, foetal death rate, size of litter, sex of the newly born, and their ability to perform. Other studies [Michaelson et al., 1976] reported a faster development of rat foetuses. This finding agrees with another report [Johnson et al., 1977] that noted an increase in the weight of newly born rats and a premature opening of the eyes after prenatal irradiation (5 mW/cm^2 at 918 MHz, for 380 h), as well as an impaired ability to learn. On the other hand, other studies found lower average weight at birth. At medium power density levels (10, 20, and 50 mW/cm^2, at 2375 MHz), which are above the limits imposed by CENELEC and the relevant IEEE standard, the reproductive capacity of mice was somewhat impaired, with smaller litter size and a rise in neonatal mortality, which is a direct function of the power flux density [Il'Cevic and Gordodeckaja, 1976; McRee, 1980].

Although it is difficult to explain this foetal development increase, we believe that it could be due to a favourable placental nourishment of the foetuses during the pregnancy. In fact, this finding could be associated with:

(a) reproductive causes, i.e., blood-flow to a smaller number of foetuses, because of the reduction of the fertility of the irradiated males or females,

(b) thermal causes, i.e., possible increase of the blood flow of the dams, directly due to the RF irradiation,

(c) endocrinological causes, i.e., increase of the somatotrophic hormone because of the RF irradiation and

(d) environmental causes, i.e., the vasodilatation and partial increase of the blood pressure of the experimental dams because of the mountain altitude.

Of course combinations of these possibilities cannot be excluded.

According to various references [Tell and Harlen, 1979; Lu et al., 1980; Deschaux et al., 1983] discrepancies between the results of experiments may be due to different experimental conditions, random formation of hot spots in the glands and the hypothalamus, or a variety of other factors, as the cicardian rhythm and differences between species. With the exception of the high power effects on testicles, that do not belong to the endocrine ensemble, the interaction seems to involve the pituitary gland or even the central nervous system rather than the terminal glands.

We would close this discussion with what Jacques Thuery wrote (1991), that the true state of affairs is probably far more complex, but the available data are not sufficient to allow us to outline it more clearly, and that all attempts to extrapolate these results to humans lead to very high power densities, partly because geometric resonance effects are very significant in small animals. Consequently, taking into account the constant exposure of the human population living close to the "antenna park" to low intensity RF radiation, these adverse health effects in mice resulting from chronic or prolonged exposure may prove of importance in the near future. Indeed, there is evidence that chronic exposure to low-intensity RF radiation may be associated with health effects different to embryo-toxicity [Salford et al., 1992; Cleary, in press].

The findings of this preliminary experimental study have led to several conclusions. Of course, the final word to the problem in question has not been said as yet. Therefore, more work is called for; laboratory-based simulation might provide valuable information.

ACKNOWLEDGMENTS

The authors thank I. Grivas, G. Marangos, and V. Oiconomou, students of the Faculty of Veterinary Medicine of Thessaloniki, and Mr. I. Milarakis of the Department of Telecommunications of the School of Electrical Engineering and Computer Engineering, who followed this experimental study and offered their technical assistance.

REFERENCES

CENELEC ENV50166-2: Human exposure to electromagnetic fields. High frequency (10 kHz to 300 GHz).

Chernoff N, Roger JM, Kavet R (1992): A review of the literature on potential reproductive and developmental toxicity of electric and magnetic fields. Toxicology, 74:91–126.

Cleary SF (1988): Biological effects of non-ionising radiation. In Webster E (ed): "Encyclopaedia of Medical Devices and Technology," Vol. 1, New York: John Wiley & Sons, pp 274–303.

Cleary SF (1990): Biological effects of radio-frequency electromagnetic fields. In Gandhi OP (ed): "Biological Effects and Medical Applications of Electromagnetic Energy." Englewood Cliffs, NJ: Prentice Hall, pp 236–255.

Cleary SF (in press): Electromagnetic energy: Biological effects and possible health significance. In Craighead J (ed): "The Pathology of Human Environmental and Occupational Disease." Boston: Mosby YearBook.

Deschaux P, Jimenez C, Santini R, Pellissier J (1983): Effet d' un rayonnement micro-onde sur la reproduction de la souris male. Econ, progrs electr., No 8-9. Mars-Juin, 15–17.

IEEE std. C95.3.1991: "IEEE recommended practice for the measurement of potentially hazardous electromagnetic fields-RF and microwaves."

IEEE C95.1.1991: "IEEE standard for safety levels with respect to human exposure to RF electromagnetic fields, 3 KHz to 3 GHz."

Il'Cevic N, and Gordodeckaja S (1976): Effects of the chronic application of the electromagnetic microwave fields on the function and morphology of the reproductive organs of animals. US joint Pub Res Serv Rep, JPRS, L/5615, Feb. 5–7.

Jensh R, Ludlow J, Weinberg I, Vogel W, Rudder T, Brent R (1977): Teratogenic effects on rat offspring of non-thermal chronic prenatal microwave irradiation. Teratology 15/2, 14 A.

Jensh R, Ludlow J, Weinberg I, Vogel W, Rudder T, Brent R (1978a): Studies concerning the postnatal effects of protracted low dose prenatal 915 MHz microwave radiation. Teratology 17/2, 21 A.

Jensh R, Ludlow J, Weinberg I, Vogel W, Rudder T, Brent R (1978b): Studies concerning the effects of protracted prenatal exposure to a non-thermal level of 2450 MHz microwave radiation in the pregnant rat. Teratology 17/2, 48 A.

Johnson R, Mizumari S, Myers D, Guy A, Lovely R (1977): Effects of pre- and post-natal exposures to 918 MHz microwave radiation on development and behaviour in rats. In International Symposium of biological effects of electromagnetic waves. Airlie.

Lary JM, Conover DL, Johnson PH, Burg JAR (1983): Teratogenicity of 27.12 MHz radiation in rats is related to duration of hyperthermic exposure. Bioelectromagnetics 4:249–255.

Lary JM, Conover DL, Johnson PH, Hornung RW (1986): Dose-response relationship between body temperature and birth defects in radiofrequency-irradiated rats. Bioelectromagnetics 7:141–149.

Lary JM, Conover DL (1987): Teratogenic effects of radio-frequency radiation. IEEE Engineering in Medicine and Biology Magazine, March.

Lu S, Lotz G, Michaelson S (1980): Advances in microwave induced neuroendocrine effects: the concept of stress. Proc. IEEE, 68, No 1:73–77.

McRee D (1980): Soviet and Eastern European research on biological effects on microwave radiation. Proc IEEE 68/1:84–91.

Michaelson S, Guillet R, Catallo M, Small J, Inamine G, Heggeness F (1976): Influence of 2450 MHz microwaves on rats exposed in utero. Proceedings of the IMPI Symposium 5A/3, Leuven.

Noden MD, Delahunta A (1985): The embryology of domestic animals. Baltimore: Williams & Wilkins.

O'Connor ME (1980): Mammalian teratogenesis and radio-frequency fields. Proc IEEE 68:56–61.

Peters PWJ (1977): Double staining of foetal skeletons for cartilage and bone. In Neubert D, Merker HJ, Kwasogroch TE (eds): "Methods in Prenatal Toxicology." Stuttgart: George Thieme.

Salford LG, Brun A, Eberhardt JL, Persson RR (1992): Development of rat brain tumours during exposure to continuous and pulsed 915 MHz electromagnetic radiation (meeting abstract). First World Congress for Electricity and Magnetism in Biology and Medicine, June, Lake Buena Vista, FL, 27–28.

Tell R, Harlen F (1979): A review of selected biological effects and dosimetric data useful for development of radio-frequency safety standards for human exposure. J Microw Power 14, No 4:405–424.

Thuery J (1991): Microwaves: Industrial, Scientific, and Medical Applications. Grant EH (ed): London: Artech House Inc.

CHAPTER 495
ENDANGERED SPECIES

Blumberg No. 5136
EXHIBIT
IJ 8

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Sec. 26-303. Findings. Policy. The General Assembly finds that certain species of wildlife and plants have been endered extinct as a consequence of man's activities and that other species of wildlife and plants are in danger of or reatened with extinction or have been otherwise reduced or may become extinct or reduced because of destruction, dification or severe curtailment of their habitats, exploitation for commercial, scientific, educational, or private use or cause of disease, predation or other factors; that such species are of ecological, scientific, educational, historical, conomic, recreational and aesthetic value to the people of the state, and that the conservation, protection and ancement of such species and their habitats are of state-wide concern. Therefore the General Assembly declares it is a licy of the state to conserve, protect, restore and enhance any endangered or threatened species and essential habitat.

(P.A. 89-224, S. 1, 22.)

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Sec. 26-304. Definitions. As used in sections 22a-2, 23-5c, 23-74, 23-75, 26-40c, 26-40d, 26-40f and 26-303 to 26-15, inclusive:

(1) "Department" means the Department of Environmental Protection;

(2) "Conserve" and "conservation" mean to use all methods and procedures necessary to maintain or increase the oulations of any endangered or threatened species to the point at which the provisions of sections 22a-2, 23-5c, 23-74, 3-75, 26-40c, 26-40d, 26-40f and 26-303 to 26-315, inclusive, are no longer necessary, including, but not limited to, all ivities associated with resources management, such as research, census, monitoring, regulation and law enforcement, itat acquisition, restoration and maintenance, propagation, live trapping, transplantation and regulated taking;

(3) "Wildlife" means all species of invertebrates, fish, amphibians, reptiles, birds and mammals which are wild by ure and parts thereof;

(4) "Plants" means any member of the plant kingdom and parts thereof;

(5) "Native" means any species indigenous to this state;

(6) "Species" means any species, subspecies, or variety of animal or plant, and includes any distinct population gment of any animal or plant;

(7) "Endangered species" means any native species documented by biological research and inventory to be in danger extirpation throughout all or a significant portion of its range within the state and to have no more than five ccurrences in the state, and any species determined to be an "endangered species" pursuant to the federal Endangered pecies Act;

(8) "Threatened species" means any native species documented by biological research and inventory to be likely to ecome an endangered species within the foreseeable future throughout all or a significant portion of its range within the te and to have no more than nine occurrences in the state, and any species determined to be a "threatened species" ursuant to the federal Endangered Species Act, except for such species determined to be endangered by the ommissioner in accordance with section 26-306;

(9) "Species of special concern" means any native plant species or any native nonharvested wildlife species ocumented by scientific research and inventory to have a naturally restricted range or habitat in the state, to be at a low pulation level, to be in such high demand by man that its unregulated taking would be detrimental to the conservation its populations or has been extirpated from the state;

(10) "Endangered Species Act" means the Endangered Species Act of 1973, Public Law 93-205, as amended from ime to time;

(11) "Take" or "taking" mean to capture, collect, destroy, harm, hunt, kill, pursue, shoot, trap, snare, net, possess, ansport, remove, sell or offer for sale, export or import or to attempt to engage in any such conduct or any act of ssistance to any other person in taking or attempting to take such native wildlife and native plants whether or not such results in capture or collection;

(12) "Essential habitat" means the geographic area which contains those physical or biological features which are ntifiable and have been demonstrated as being decisive to the continued existence of any endangered or threatened pecies and includes, but is not limited to, significant areas used for courtship, mating, and other reproductive activities, earing of young, feeding and shelter of endangered and threatened species;

(13) "Destruction or adverse modification of essential habitat" means any activity that significantly alters, pollutes, npairs, degrades, damages, destroys or otherwise reduces the ability of the habitat to sustain populations of endangered threatened species;

(14) "Threaten the continued existence" means to engage in any action that reduces appreciably the likelihood of the vival and recovery of an endangered or threatened species in the wild by reducing the reproduction, numbers, or istribution of such species;

(15) "Occurrence" means a population of a species breeding and existing within the same ecological community and apable or potentially capable of interbreeding with other members of that species within that community.

(P.A. 89-224, S. 2, 22.)

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Sec. 26-305. Program for the protection of endangered and threatened species. There is established a program or the protection of endangered and threatened species. The commissioner may conduct investigations of wildlife and nts in order to develop information relating to population, distribution, habitat needs, limiting factors, essential oitats, and other biological and ecological data to determine conservation and management measures necessary for eir continued ability to sustain themselves successfully.

(P.A. 89-224, S. 3, 22.)

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Sec. 26-306. Regulations. Determination of whether any native species is endangered, threatened or of special ncern. List. Essential habitats identified. (a) The commissioner shall adopt regulations, in accordance with the visions of chapter 54, establishing procedures for determining whether any native species is endangered, threatened r of special concern. In making such determination, the commissioner shall consider: (1) The destruction or threatened truction, modification or curtailment of the habitat of the species; (2) overutilization of the species for commercial, reational, scientific, educational or private purposes; (3) disease, predation or competition affecting the species; (4) ne inadequacy of existing regulatory mechanisms to affect the continued existence of the species within the state; or (5) er natural or man-made factors affecting the continued existence of the species within the state.

(b) Not later than June 22, 1990, the commissioner shall adopt regulations, in accordance with the provisions of pter 54, listing native wildlife and native plants that he has determined to be endangered or threatened species or cies of special concern. Not later than June 22, 1991, the commissioner shall so adopt regulations to identify, where iologically feasible, essential habitats for endangered and threatened species.

(c) The commissioner shall adopt regulations in accordance with the provisions of chapter 54 to establish criteria to e included in a petition pursuant to section 4-174 to add or remove a species from the list of endangered or threatened cies or species of special concern or to add or remove an area identified as an essential habitat for such species.

(P.A. 89-224, S. 4, 22.)

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Sec. 26-307. Review. The commissioner shall review, at least every five years, the designation of species as langered, threatened or of special concern, and areas identified as essential habitats to determine whether he should: 1) Add or remove any species from the list of endangered or threatened species or species of special concern; (2) change ne designation from one category to another; (3) add or remove any area from the list of essential habitats for langered or threatened species. The review of species that are listed as endangered by the United State Department of erior shall be conducted, to the extent practicable, in conjunction with the periodic year review process of the Department of Interior pursuant to the Endangered Species Act.

(P.A. 89-224, S. 5, 22.)

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Sec. 26-308. Treatment of species not listed as endangered or threatened as endangered or threatened species. The commissioner may adopt regulations, in accordance with the provisions of chapter 54, to treat a species not listed endangered or threatened pursuant to section 26-306 as an endangered or threatened species if he finds that: (1) Such pecies so closely resembles a species listed as endangered or threatened that enforcement personnel would have bstantial difficulty in attempting to differentiate between it and the listed species; (2) the effect of such substantial ficulty is an additional threat to the endangered or threatened species; and (3) treatment of the unlisted species as an ndangered or threatened species would substantially facilitate enforcement and further the policy state in section 26-03.

(b) The regulations may include a provision to allow a person to conduct an activity which affects a species that embles an endangered or threatened species if the person can demonstrate to the commissioner that the activity does ot affect the endangered or threatened species.

(P.A. 89-224, S. 6, 22.)

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Sec. 26-309. State acquisition of essential habitat. Management. (a) The commissioner may acquire for and on ehalf of the state, essential habitat, or interests therein, for the conservation of endangered, threatened, or species of pecial concern by gift, devise, purchase, exchange, condemnation or any other method of acquiring real property or an erest therein.

(b) The commissioner may enter into agreements with federal agencies, or political subdivisions of this state or other tes, or with individuals or private organizations for administration and management of any program established and tilized for the conservation of endangered and threatened species and for management of any area identified as essential abitat for such species pursuant to section 26-306.

(P.A. 89-224, S. 7, 22.)

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Sec. 26-310. Actions by state agencies which affect endangered or threatened species or species of special ncern or essential habitats of such species. (a) Each state agency, in consultation with the commissioner, shall onserve endangered and threatened species and their essential habitats, and shall ensure that any action authorized, unded or performed by such agency does not threaten the continued existence of any endangered or threatened species result in the destruction or adverse modification of habitat designated as essential to such species, unless such agency as been granted an exemption as provided in subsection (c) of this section. In fulfilling the requirements of this section, ach agency shall use the best scientific data available.

(b) Each state agency responsible for the primary recommendation or initiation of actions on land or in aquatic abitats which may significantly affect the environment, as defined in section 22a-1c, shall ensure that such actions are nsistent with the provisions of sections 26-303 to 26-312, inclusive, and shall take all reasonable measures to mitigate y adverse impacts of such actions on endangered or threatened species or essential habitat. The Secretary of the Office f Policy and Management shall consider the consistency of such proposed actions with the provision of said sections -303 to 26-312, inclusive, in determining whether or not an environmental impact evaluation prepared pursuant to tion 22a-1b satisfies the requirements of sections 22a-1a to 22a-1h, inclusive, and regulations adopted pursuant to said ections.

(c) If the Secretary of the Office of Policy and Management, in consultation with the commissioner, determines that a roposed action violates subsections (a) or (b) of this section and there are no feasible and prudent alternatives the state ency may apply to the commissioner for an exemption. The commissioner may grant an exemption after considering following factors: (1) The agency did not make an irreversible or irretrievable commitment of resources after itiation of consultation with the department that forecloses the opportunity for formulating and implementing feasible d prudent alternatives, (2) the benefits of the action clearly outweigh the benefits of alternative courses of action, nsistent with conserving the species or its essential habitat, and such action is in the public interest, (3) the action is of egional or state-wide significance, and (4) the agency plans to take reasonable mitigation and enhancement measures cessary and appropriate to minimize the adverse impacts of the action upon the species or essential habitat, including, t not limited to, live propagation, transplantation, and habitat acquisition and improvement.

(d) If the Secretary of the Office of Policy and Management, in consultation with the commissioner, determines that a oposed action would not appreciably reduce the likelihood of the survival or recovery of an endangered or threatened cies, but would result in the incidental taking of such species, the commissioner shall provide the state agency with a itten statement that: (1) Specifies the impact of such incidental taking on the species; (2) specifies feasible and prudent easures and alternatives that shall be implemented as part of the proposed project in order to ensure that the action does t appreciably reduce the likelihood of the recovery of the species; and (3) sets forth terms and conditions including, but t limited to, reporting requirements to ensure compliance with this subsection. Any taking that is in compliance with e measures and alternatives specified pursuant to this subsection shall not be prohibited by sections 26-303 to 26-312, lusive.

(P.A. 89-224, S. 8, 22.)

History: (Revisor's note: In 1993 an incorrect reference in Subsec. (b) to Sec. 36-312 was changed editorially by the evisors to Sec. 26-312).

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Sec. 26-311. Taking of endangered or threatened species. Construction of chapter. (a) Except as otherwise vided in section 26-310, it is unlawful for (1) any person to wilfully take any endangered or threatened species on or rom public property, waters of the state or property of another without the written permission of the owner on whose perty the species occurs; (2) any person, including the owner of the land on which an endangered or threatened cies occurs, to wilfully take an endangered or threatened species for the purpose of selling, offering for sale, ansporting for commercial gain or exporting such specimen; (3) any state agency to destroy or adversely modify ential habitat designated pursuant to section 26-306, so as to reduce the viability of the habitat to support endangered threatened species or so as to kill, injure, or appreciably reduce the likelihood of survival of the species.

(b) Nothing in sections 26-303 to 26-312, inclusive, or any regulation adopted pursuant to said sections shall prohibit erson from performing any legal activities on his own land that may result in the incidental taking of endangered or reatened animal and plant species or species of special concern.

(c) Nothing in sections 26-303 to 26-312, inclusive, or any regulations adopted pursuant to said sections shall rohibit any action authorized pursuant to an exemption or permit provided for by the federal Endangered Species Act or any regulation adopted under said act, or permit any action prohibited by the Endangered Species Act or by any ulation adopted under said act.

(d) Nothing in sections 26-303 to 26-312, inclusive, or any regulations adopted pursuant to said sections shall hibit transportation through this state of any endangered or threatened species in accordance with the terms of any ermit issued under the laws of another state provided the person in possession of an endangered or threatened species n prove legal possession of the species.

(e) The commissioner may prohibit, in an emergency, the taking of any state species of special concern threatened th undue depletion from overutilization of the species for commercial, recreational, scientific, educational or private poses.

(P.A. 89-224, S. 9, 22.)

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Sec. 26-312. Violation. Order. Hearing. If the commissioner or his duly authorized agent finds that any person is nducting any activity or maintaining a facility or condition which is in violation of section 26-311, the commissioner hall issue a written order by certified mail to such person to cease immediately such activity or to correct such facility or ndition. Within ten days of the issuance of such order the commissioner shall hold a hearing to provide the person an portunity to be heard and show cause why the order should not remain in effect. The commissioner shall consider the

:ts presented at the hearing and within ten days of the completion of the hearing notify the person by certified mail that ıe original order remains in effect, that a revised order is in effect, or that the order has been withdrawn. The original rder shall be effective upon issuance and shall remain in effect until the commissioner affirms, revises or withdraws the ler. The issuance of an order pursuant to this section shall not delay or bar an action pursuant to section 26-40c.

(P.A. 89-224, S. 10, 22.)

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Sec. 26-313. Disclosure. Notwithstanding the provisions of the Freedom of Information Act, as defined in section 1-0, the Commissioner of Environmental Protection may withhold from disclosure to any person maps and records that isclose the location of any essential habitat or that disclose the location of any threatened species, endangered species, species of special concern, upon determination that disclosure of such information to such person would create an acceptable risk of destruction of, or harm to, such habitat or species. Prior to disclosure of any maps or records to any erson, the commissioner may impose any reasonable conditions including the condition that the person to whom the formation is disclosed furnish the commissioner with security in an amount and kind sufficient to guarantee that such rson shall not destroy or harm, or cause to be destroyed or harmed, any such habitat or species. Any person whose equest for disclosure has been denied shall be afforded the opportunity for a hearing to establish that (1) the requested formation should be disclosed because disclosure would not create an unacceptable risk of destruction of, or harm to, :h habitat or species and (2) the unreasonableness of any condition imposed, including the amount or kind of any ecurity to be established. Any hearing or other proceeding pursuant to this section shall be held in accordance with the ovisions of chapter 54.

(P.A. 89-224, S. 18, 22; P.A. 97-47, S. 24.)

History: P.A. 97-47 substituted reference to "the Freedom of Information Act, as defined in Sec. 1-18a" for list of ections.

(Return to Chapter Table of Contents) (Return to List of Chapters) (Return to List of Titles)

Sec. 26-314. Natural Area Preserves Advisory Committee. There is established a Natural Area Preserves Advisory mmittee which shall consist of seven members. Three members shall be employees of the Department of vironmental Protection and shall serve at the pleasure of the Commissioner of Environmental Protection, one of whom ıe commissioner shall designate as chairman of the committee, and four members shall be appointed by the Governor m persons with an interest in the preservation of lands in natural condition for scientific and educational purposes. embers appointed by the Governor shall serve for four years. The Governor shall fill any vacancy among his ppointees for the remainder of the unexpired term. The committee shall meet semiannually and may meet more often on the call of the chairman. The members of the committee shall receive no compensation for their services as such t may be reimbursed for necessary expenses in connection with the performance of their duties. Members shall be ersons with experience or professional training in ecological, biological or natural sciences, or environmental education; representatives of institutions with experience in natural area research, education or preservation. The committee shall et semiannually and may meet more often upon the call of the chairman or the call of any four members, upon elivery of forty-eight hours written notice to each member. The commissioner shall provide technical staff and clerical pport services to carry out the business of the committee. The Natural Area Preserves Advisory Committee shall vise the Commissioner of Environmental Protection relative to the administration of sections 23-5a to 23-5i, inclusive, nd shall cooperate with the commissioner (1) in the establishment of standards for the acquisition, designation, intenance and operation of natural area preserves within the system; (2) in making periodic state-wide surveys to termine the availability of that land which should be designated as a natural area preserve; (3) in recommending the cquisition of specific lands or interests in lands which are suitable for natural area preserves; (4) in preparing and sseminating literature and other materials to inform the public with respect to the natural area preserve program; (5) in nsulting and cooperating with conservation and naturalist groups and organizations in the acquisition and maintenance f natural area preserves; (6) in recommending the acquisition of specific lands or interests in lands which are suitable natural area preserves with funds available under the recreation and natural heritage trust program or other programs under which funds are available to the commissioner; (7) in the preparation of management plans for specific natural area preserves; and (8) in recommending the alienation or revocation of a natural area preserve for just cause.

(P.A. 89-224, S. 19, 22; P.A. 91-65, S. 6.)

History: P.A. 91-65 added language detailing qualifications for members of the committee and expanded duties to include designation of preserves under Subdiv. (1) and to include duties enumerated in new Subdivs. (6) to (8), inclusive.

(Return to Chapter Table of Contents) (Return to List of Chapters) (Return to List of Titles)

Sec. 26-315. Elephant ivory. If the Commissioner of Environmental Protection determines that trade in Connecticut of raw elephant ivory or products manufactured or derived from elephant ivory contributes to the extinction or endangerment of elephants, he shall adopt regulations in accordance with the provisions of chapter 54 to regulate such trade.

(P.A. 89-224, S. 20, 22.)

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Sec. 26-316. Eelgrass beds. The Commissioner of Environmental Protection shall adopt regulations, in accordance with chapter 54, to protect and restore eelgrass, including the protection of existing eelgrass beds from degradation, the development of a restoration plan to restore eelgrass and the periodic monitoring of the effectiveness of such measures to protect and restore eelgrass.

(P.A. 02-50, S. 4.)

History: P.A. 02-50 effective June 9, 2002.

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EXHIBIT
IJ9
Blumberg No. 5136

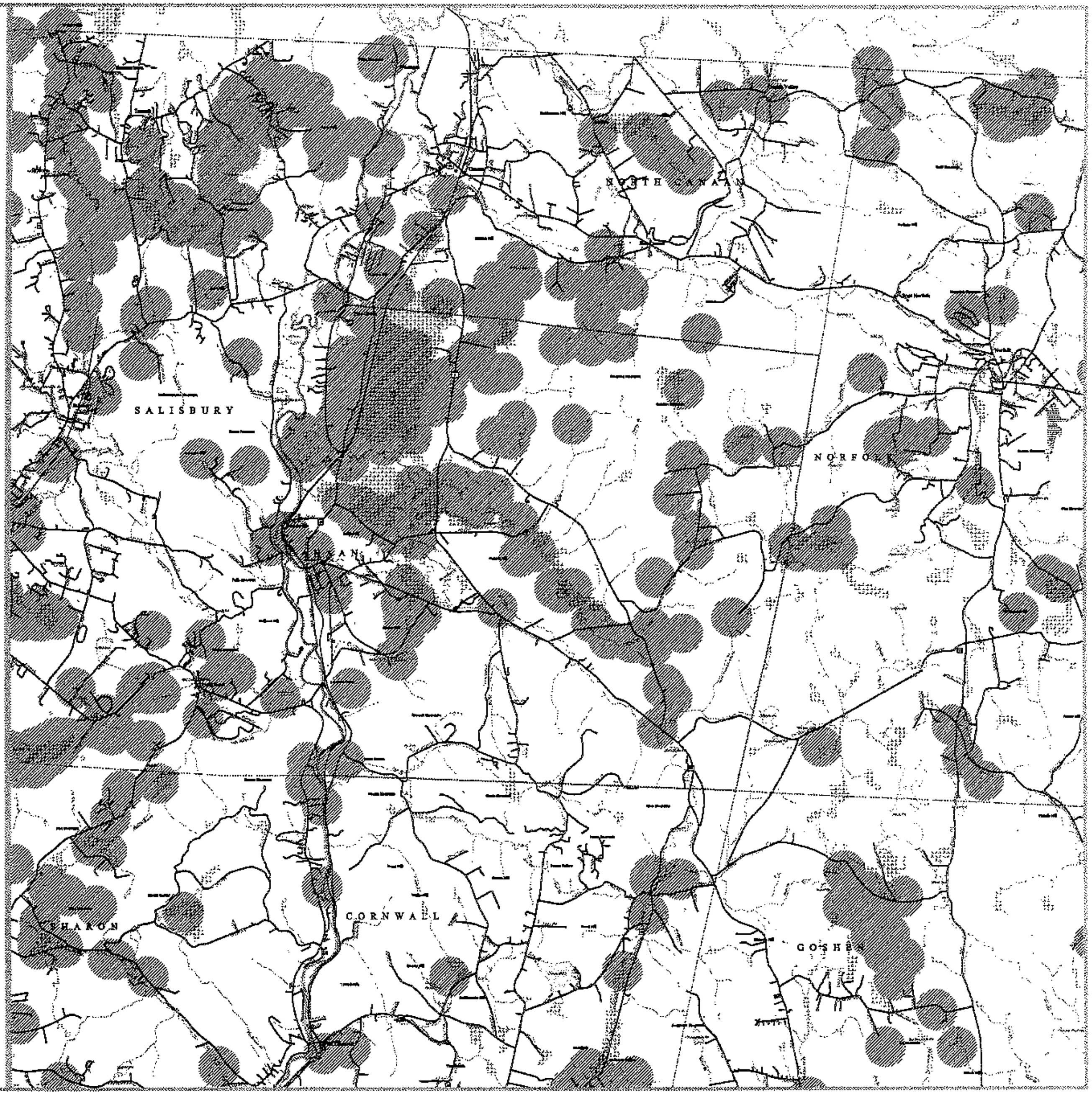
STATE AND FEDERAL LISTED SPECIES
AND SIGNIFICANT NATURAL COMMUNITIES
CANAAN, CT

LEGEND

NDDB Area of Concern *

TO USE MAP

DATA SOURCES



Blumberg No. 5136
EXHIBIT
IJ 10

TO USE MAP

Locate project boundaries and any additional affected areas on the map. If the project is not within a shaded area; or overlapping a lake, pond or wetland that has any shading; or upstream or downstream (by less than 1/2 mile) from a shaded area, the project is unlikely to affect any known occurrence of listed species or significant natural community. If any part of the project is within a shaded area; or overlapping a lake, pond, or wetland that has any shading; or upstream or downstream (by less than 1/2 mile) from a shaded area, then the project may have a potential conflict with a species or natural community. Complete a Data Base Request Form and submit to the Natural Diversity Data Base along with a project description and a copy of a map clearly showing the project boundaries.

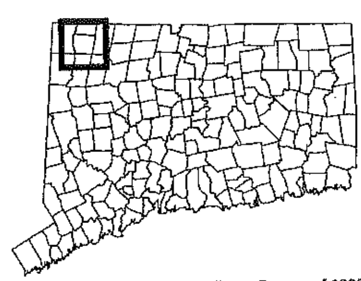
DATA SOURCES

BASE MAP INFORMATION - Political boundaries, railroads, and hydrography originally derived from 1:24,000 scale 7.5 Minute U.S. Geological Survey Digital Line Graphs and enhanced by the Connecticut Department of Environmental Protection. The data is based on 1:24,000 scale Topographic Quadrangle maps published between 1969 and 1984. The roads and road names are based on the Connecticut Street Network State Plane, TIGER/Line 2000 database a statewide database of address-ranged street segments compiled from the Census 2000 TIGER/Line files by the University of Connecticut Center for Geographic Information and Analysis. Annotation derived in part from U.S. Geological Survey Geographic Names Information System and information on file at the Connecticut Department of Environmental Protection. The base map data may be neither current nor complete.

* NDDB INFORMATION - Locations of listed species and natural communities are based on data collected by the CT Department of Environmental Protection, private conservation groups and the scientific community and compiled by the Natural Diversity Data Base. The information is not necessarily the result of comprehensive or site-specific field investigations; in some cases locations have been derived from literature or museum searches or historic records. Exact locations have been buffered to produce generalized locations. The exact species or community location falls somewhere within the shaded area and not necessarily in the center. Information on this map does not include Natural Area Preserves, designated wetland areas or wildlife concentration areas.

Date of Map: June 2006,
Natural Diversity Database Digital Data

For inquiries about the State and Federal Listed Species and Significant Natural Communities map: Contact DEP, Bureau of Natural Resource, Wildlife Division. Tel: 860-424-3011



State Plane Coordinate System of 1983, Zone 3526
Lambert Conformal Conic Projection
North American Datum of 1983

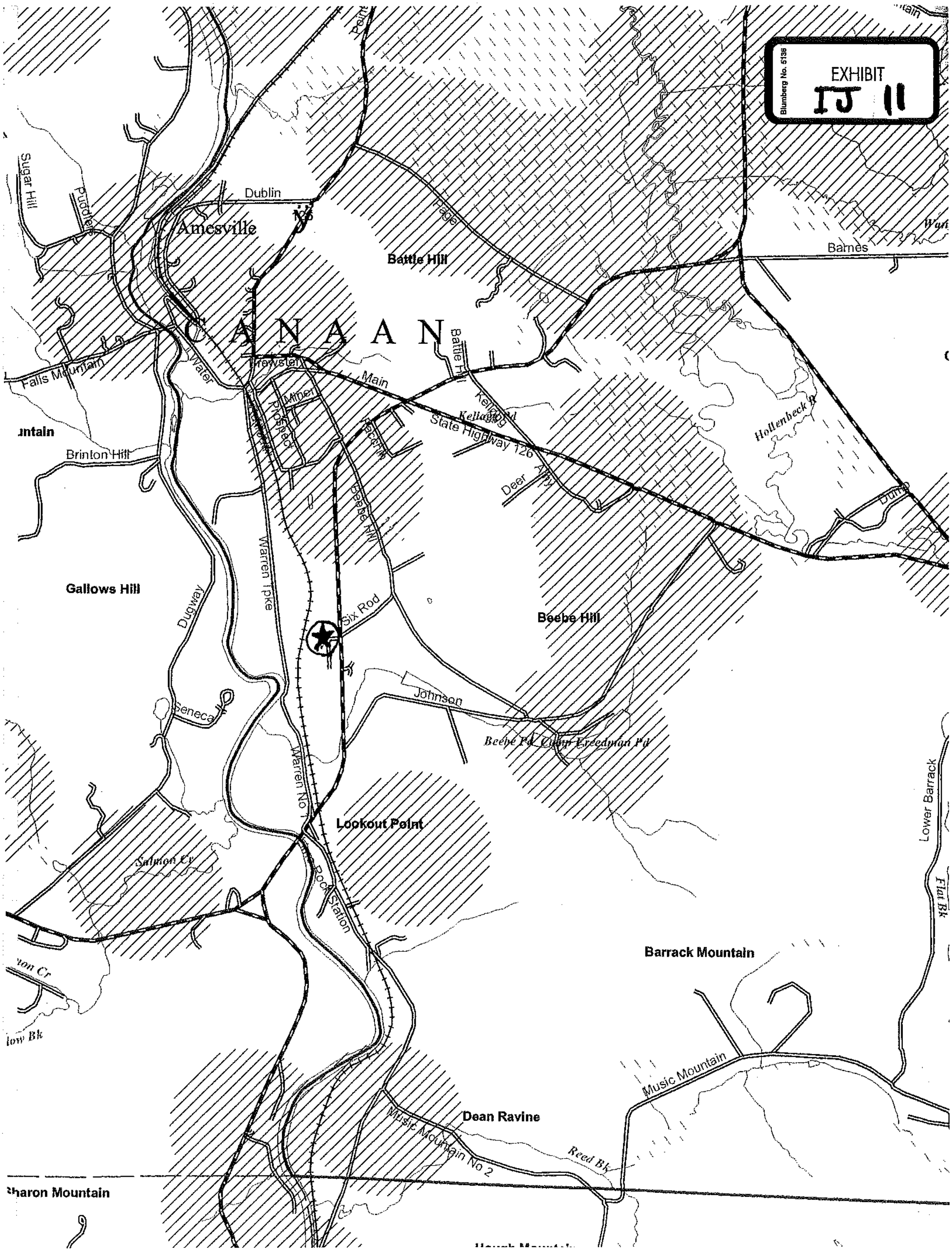


EXHIBIT
IJ 11
Blumberg No. 5136
CANAAN
Amesville
Sugar Hill
Puddle
Dublin
Battle Hill
Page
Barnes
Falls Mountain
Water
Brewster
Main
Miner
Prospect
Battle Hill
Kellogg
Kellogg Pd
State Highway 126
Hollenbeck R
Brinton Hill
Deer
Beebe Hill
Warren Tpke
Gallows Hill
Dugway
Six Rod
Beebe Hill
Johnson
Seneca
Beebe Pd
Camp Freedman Pd
Warren No 1
Lookout Point
Salmon Cr
Rock Station
Lower Barrack
Flat Bk
Barrack Mountain
Music Mountain
Dean Ravine
Music Mountain No 2
Reed Bk
Sharon Mountain

The Nature Conservancy
SAVING THE LAST GREAT PLACES ON EARTH

EXHIBIT
IJ 12

Northwest Highlands

Connecticut's Northwest Highlands Program focuses on conserving the natural resources of northwestern Connecticut, including the vast chain of forest blocks and important waterways and watersheds stretching from Kent to Hartland. This region contains spectacular biological diversity, including more than 150 rare and endangered plants and animals - the highest concentration in Connecticut.


Hollenbeck Preserve, Falls Village
© Christopher S. Wood

The Nature Conservancy has been active in Connecticut's Northwest Highlands for more than 47 years, establishing its first preserve in the state at Beckley Bog in Norfolk in 1957. The rolling Berkshire foothills, dotted with picturesque villages, comprise some of Connecticut's last untouched natural areas. Large and ecologically significant tracts of unfragmented forest remain, representing extraordinary conservation opportunities.

The Northwest Highlands feature rugged uplands such as Canaan Mountain, an 8-mile range rising steeply to a series of summits, one as high as 1,962 feet. The area is made up largely of rocky ledges and a diversity of vegetation, including 1,200 acres of forest that have been protected from indiscriminate cutting for the past 50 years. A total of almost 5,000 acres are protected on Canaan Mountain today.

Adjacent to Canaan Mountain is the Hollenbeck River and its watershed, which includes Robbins Swamp, Connecticut's largest inland wetland. Robbins Swamp represents one of the region's most significant environments: calcareous wetlands. These open wetlands are influenced by underlying marble bedrock, making them alkaline, unlike most New England wetlands, which are acidic. Calcareous wetlands provide an uncommon environment and host a number of rare plants and animals. Nearby Wangum Lake Brook, which drains into the Hollenbeck River, is also part of this calcareous wetland complex.

Together, Canaan Mountain and Robbins Swamp are home to a variety of rare animals and plants, including the endangered timber rattlesnake and northern metalmark butterfly, three rare bird species, and 23 rare species of plants, including a variety of trees, flowering plants, grasses, and sedges.

In the Northwest Highlands, the Conservancy is working cooperatively with local landowners and conservation partners to preserve a network of land and waterways, to safeguard the ecological processes in those areas, and to manage land to protect rare species and natural communities.

The Northwest Highlands Program and the Conservancy's Berkshire-Taconic Landscape Program (BTLP) based in Sheffield, Mass., complement one another. BTLP focuses on the area where Connecticut, Massachusetts, and New York converge, and centers on a mountainous 56-square-mile forest at its core.

News:
Greg Overton Directs Northwest Highlands Program Read Press Release

Contact:
For more information on this program, please contact:
Greg Overton, Northwest Highlands Program Director
24 Center Street
Winsted CT 06098
tel (860) 738-9324
fax (860) 738-9329
goverton@tnc.org

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Instructions for Completing a Connecticut Natural Diversity Data Base Review Request Form

EXHIBIT
IJ 13

Introduction

Section 26-310 of the Connecticut General Statutes (CGS) provides that any activity authorized by a state agency, including any activity issued a permit by DEP, must not threaten the continued existence of any endangered or threatened species. If your activity is located in an area of concern, DEP's Connecticut Natural Diversity Data Base (CT NDDB) program will conduct a detailed review to determine if there will be any impact from your project and you will be notified of their results.

Note that current research projects and new contributors continue to identify additional populations of species and locations of habitats of concern, as well as, enhance existing data. Such new information is incorporated into the CT NDDB as it becomes available. Therefore, please be aware that additional information and/or surveys, other than those specified in this section, may be required to support the CT NDDB.

How to Use the Maps

DEP has produced a set of maps entitled "State and Federal Listed Species and Natural Communities" (NDDB maps). These maps serve as a preliminary screening tool to assist in the evaluation of impacts to endangered and threatened species.

In order to determine whether your proposed activity may threaten the continued existence of an endangered or threatened species, you should review the NDDB maps. The maps are available in the DEP File Room at 79 Elm Street, Hartford, as well as with each town planner and on-line at http://www.dep.state.ct.us/cgnhs/nddb/nddbpdfs.asp. NDDB printed maps and GIS data are also available for purchase from the DEP Store.

The maps are based on USGS quadrangle maps and cover the entire State of Connecticut. To use the maps, locate the project boundaries and any additional impacted areas on the appropriate map(s). If you are not sure on which quadrangle the project is located, use the quadrangle index map to identify the appropriate quadrangle(s).

No Conflict

If the project is **not**

- within a shaded area; or
- overlapping a water body that has any shading; or
- upstream or downstream (by less than ½ mile) from a shaded area

the project will not impact any known occurrence of listed species or significant natural community. If you are applying for a DEP permit, indicate, in the site information section of the relevant permit application form, that the maps were reviewed and list the date of the map (located in the map legend). You do not need to complete and submit the *CT NDDB Review Request Form* (DEP-APP-007).

Potential Conflict

If any part of the project **is**

- within a shaded area; or
- overlapping a water body that has any shading; or
- upstream or downstream (by less than ½ mile) from a shaded area

then the project may have a conflict with a species or natural community.

In the case of a potential conflict, a completed *CT NDDB Review Request Form* (DEP-APP-007) with a project description and a copy of a map (a 1:24,000 USGS quadrangle map) clearly showing the project boundaries must be submitted to the NDDB program at the address specified on the form. If a field survey of the project area has been previously conducted to identify any presence of endangered, threatened or special concern species, indicate, on the *CT NDDB Request Form*, the biologist's name who conducted the field survey, his or her address, and include a copy of the field survey, with the completed *CT NDDB Request Form*.

NDDB staff will perform a more detailed review of projects identified as having potential conflicts. (Note: NDDB review generally takes four to six weeks.) Depending on the nature and scope of the proposed project, you may be required to obtain additional on-site surveys.

NDDB will return a "no conflict" response if listed species or significant natural communities will not be impacted based on the scope of the project activities and project location. This "no conflict" response can be submitted with the permit application form or forwarded to the DEP permit analyst working on your project.

If the project potentially impacts listed species or significant natural communities, appropriate DEP staff will provide recommendations to you and staff reviewing your project to avoid endangered and threatened species or recommendations to minimize impacts to species of special concern and significant natural communities. The comments will vary depending on the scope of the proposed project or activity and the extent of the information available on the species or community to be impacted. DEP staff reviewing permit applications will take these recommendations and comments into account while conducting their review and may incorporate appropriate conditions into their permit decisions.

If you have any questions on this process prior to submitting your application, call the Permit Assistance Office 860-424-3003.

Connecticut Natural Diversity Data Base Review Request Form

Please complete this form *only* if you have conducted a review which determined that your activity is located in an area of concern.

Name:

Affiliation:

Mailing Address:

City/Town: State: Zip Code:

Business Phone: ext. Fax:

Contact Person: Title:

Project or Site Name:

Project Location

Town: USGS Quad:

Brief Description of Proposed Activities:

Have you conducted a "State and Federal Listed Species and Natural Communities Map" review?

☐ Yes ☐ No Date of Map:

Has a field survey been previously conducted to determine the presence of any endangered, threatened or special concern species? ☐ Yes ☐ No

If yes, provide the following information and submit a copy of the field survey with this form.

Biologists Name:

Address:

If the project will require a permit, list type of permit, agency and date or proposed date of application:

(See reverse side - you must sign the certification on the reverse side of this form)

The Connecticut Natural Diversity Data Base (CT NDDB) information will be used for:

- ☐ permit application
- ☐ environmental assessment (give reasons for assessment):
- ☐ other (specify):

"I certify that the information supplied on this form is complete and accurate, and that any material supplied by the CT NDDB will not be published without prior permission."

Signature ____________________ Date ____________________

All requests must include a USGS topographic map with the project boundary clearly delineated.

Return completed form to:

WILDLIFE DIVISION
BUREAU OF NATURAL RESOURCES
DEPARTMENT OF ENVIRONMENTAL PROTECTION
79 ELM ST, 6TH FLOOR
HARTFORD, CT 06106-5127

* You must submit a copy of this completed form with your registration or permit application.

EXHIBIT IJ 14

Blumberg No. 5136

A County Report of
Connecticut's Endangered, Threatened and Special Concern Species

Litchfield County

Amphibians

Scientific Name	Common Name	Protection Status
Ambystoma jeffersonianum	Jefferson Salamander	SC
Ambystoma laterale	Blue-spotted Salamander	T
Gyrinophilus porphyriticus	Northern Spring Salamander	T
Plethodon glutinosus	Northern Slimy Salamander	T
Rana pipiens	Northern Leopard Frog	SC

Birds

Scientific Name	Common Name	Protection Status
Accipiter striatus	Sharp-shinned Hawk	E
Aegolius acadicus	Northern Saw-whet Owl	SC
Ammodramus henslowii	Henslow's Sparrow	SC*
Ammodramus savannarum	Grasshopper Sparrow	E
Anas discors	Blue-winged Teal	T
Asio otus	Long-eared Owl	E
Bartramia longicauda	Upland Sandpiper	E
Botaurus lentiginosus	American Bittern	E
Caprimulgus vociferus	Whip-poor-will	SC
Circus cyaneus	Northern Harrier	E
Cistothorus platensis	Sedge Wren	E
Corvus corax	Common Raven	SC
Empidonax alnorum	Alder Flycatcher	SC
Eremophila alpestris	Horned Lark	E
Falco sparverius	American Kestrel	T
Gallinula chloropus	Common Moorhen	E
Gavia immer	Common Loon	SC

Litchfield County

Birds

Scientific Name	Common Name	Protection Status
Haliaeetus leucocephalus	Bald Eagle	E
Ixobrychus exilis	Least Bittern	T
Melanerpes erythrocephalus	Red-headed Woodpecker	E
Parula americana	Northern Parula	SC
Passerculus sandwichensis	Savannah Sparrow	SC
Podilymbus podiceps	Pied-billed Grebe	E
Pooecetes gramineus	Vesper Sparrow	E
Progne subis	Purple Martin	T
Sturnella magna	Eastern Meadowlark	SC
Tyto alba	Barn Owl	E
Vermivora chrysoptera	Golden-winged Warbler	E

Fish

Scientific Name	Common Name	Protection Status
Catostomus catostomus	Longnose Sucker	SC
Lota lota	Burbot	E

Invertebrates

Scientific Name	Common Name	Protection Status
Acronicta albarufa	Barrens Dagger Moth	SC*
Amblyscirtes vialis	Common Roadside Skipper	T
Anarta luteola	Yellow Anarta	E
Anthopotamus verticis	Walker's Tusked Sprawler	SC
Apamea burgessi	A Noctuid Moth	SC
Atylotus ohioensis	Tabanid Fly	SC
Bembidion quadratulum	A Ground Beetle	SC
Calephelis borealis	Northern Metalmark	E
Callophrys irus	Frosted Elfin	T
Chaetaglaea cerata	A Noctuid Moth	SC*

Litchfield County

Invertebrates

Scientific Name	Common Name	Protection Status
Cicindela purpurea	A Tiger Beetle	SC*
Cicindela tranquebarica	Dark Bellied Tiger Beetle	SC
Cinygmula subaequalis	A Mayfly	SC
Citheronia regalis	Regal Moth	SC*
Eacles imperialis imperialis	Imperial Moth	SC*
Erynnis lucilius	Columbine Duskywing	E
Erynnis persius persius	Persius Duskywing	E
Euphyes bimacula	Two-spotted Skipper	T
Euphyes dion	Sedge Skipper	T
Exyra rolandiana	Pitcher Plant Moth	SC
Fossaria galbana	Lymnaeid snail	SC*
Gomphus adelphus	Mustached Clubtail	T
Gomphus descriptus	Harpoon Clubtail	T
Gomphus ventricosus	Skillet Clubtail	SC
Grammia speciosa	Bog Tiger Moth	E
Hemaris gracilis	Slender Clearwing	T
Hetaerina americana	American Rubyspot	SC
Hybomitra frosti	A Horse Fly	T
Hybomitra longiglossa	A Horse Fly	E
Hybomitra lurida	A Horse Fly	SC
Hybomitra typhus	A Horse Fly	SC
Hydraecia immanis	Hop Vine Borer Moth	SC*
Leucorrhinia glacialis	Crimson-ringed Whiteface	T
Ligumia nasuta	Eastern Pondmussel	SC
Lycaena epixanthe	Bog Copper	SC
Lycaena hyllus	Bronze Copper	SC
Margaritifera margaritifera	Eastern Pearlshell	SC
Meropleon ambifuscum	Newman's Brocade	SC*

Litchfield County

Invertebrates

Scientific Name	Common Name	Protection Status
Merycomyia whitneyi	Tabanid Fly	SC
Metarranthis apiciaria	Barrens Metarranthis Moth	SC*
Nicrophorus americanus	American Burying Beetle	SC*
Papaipema appassionata	Pitcher Plant Borer Moth	E
Papaipema circumlucens	Hops Stalk Borer Moth	SC*
Papaipema leucostigma	Columbine Borer	SC
Papaipema sciata	Culvers Root Borer	SC*
Phyllonorycter ledella	Labrador Tea Tentiform Leafminer	E
Psectraglaea carnosa	Pink Sallow	T
Sargus fasciatus	Soldier Fly	SC
Satyrodes eurydice	Eyed Brown	SC
Somatochlora elongata	Ski-tailed Emerald	SC
Speyeria idalia	Regal Fritillary	SC*
Tabanus fulvicallus	Horse Fly	SC
Valvata tricarinata	Threeridge Valvata	SC

Mammals

Scientific Name	Common Name	Protection Status
Lasiurus cinereus	Hoary Bat	SC
Puma concolor couguar	Eastern Cougar	SC*
Synaptomys cooperi	Southern Bog Lemming	SC

Plants

Scientific Name	Common Name	Protection Status
Abies balsamea	Balsam Fir	E
Acalypha virginica	Virginia Copperleaf	SC
Acer nigrum	Black Maple	SC
Agastache scrophulariifolia	Purple Giant Hyssop	E
Alopecurus aequalis	Orange Foxtail	T

Litchfield County

Plants

Scientific Name	Common Name	Protection Status
Amelanchier sanguinea	Roundleaf Shadbush	E
Andromeda glaucophylla	Bog Rosemary	T
Anemone canadensis	Canada Anemone	E
Angelica venenosa	Hairy Angelica	SC*
Antennaria neglecta var. petaloidea	Field Pussytoes	SC*
Aplectrum hyemale	Puttyroot	SC*
Arceuthobium pusillum	Dwarf Mistletoe	E
Arethusa bulbosa	Arethusa	SC*
Aristida longespica	Needlegrass	SC
Aristolochia serpentaria	Virginia Snakeroot	SC
Asclepias viridiflora	Green Milkweed	E
Asplenium montanum	Mountain Spleenwort	T
Asplenium ruta-muraria	Wallrue Spleenwort	T
Betula pumila	Swamp Birch	SC
Blephilia ciliata	Downy Woodmint	SC*
Blephilia hirsuta	Hairy Woodmint	SC*
Bouteloua curtipendula	Side-oats Grama	E
Calamagrostis stricta ssp. inexpansa	Reed Bentgrass	SC
Calystegia spithamaea	Low Bindweed	SC*
Cardamine douglassii	Purple Cress	SC
Carex aestivalis	Summer Sedge	SC
Carex alata	Broadwing Sedge	E
Carex alopecoidea	Foxtail Sedge	T
Carex aquatilis var. altior	Sedge	SC
Carex backii	Sedge	E
Carex bushii	Sedge	SC
Carex buxbaumii	Brown Bog Sedge	E
Carex castanea	Chestnut-colored Sedge	E

Litchfield County

Plants

Scientific Name	Common Name	Protection Status
Carex crawei	Crawe's Sedge	T
Carex crawfordii	Crawford Sedge	SC*
Carex cumulata	Clustered Sedge	T
Carex davisii	Davis' Sedge	E
Carex foenea	Bronze Sedge	SC*
Carex formosa	Handsome Sedge	SC
Carex hitchcockiana	Hitchcock's Sedge	SC
Carex limosa	Sedge	E
Carex lupuliformis	False Hop Sedge	SC
Carex molesta	Troublesome Sedge	SC
Carex novae-angliae	New England Sedge	SC
Carex oligocarpa	Eastern Few-fruit Sedge	SC
Carex pauciflora	Few-flowered Sedge	SC*
Carex paupercula	Sedge	E
Carex prairea	Prairie Sedge	SC
Carex pseudocyperus	Cyperus-like Sedge	E
Carex schweinitzii	Schweinitz's Sedge	E
Carex squarrosa	Sedge	SC
Carex sterilis	Dioecious Sedge	SC
Carex trichocarpa	Sedge	SC
Carex tuckermanii	Tuckerman Sedge	SC
Carex viridula	Little Green Sedge	E
Castilleja coccinea	Indian Paintbrush	E
Chamaelirium luteum	Devil's-bit	E
Coeloglossum viride var. virescens	Long-bracted Green Orchid	SC
Corallorhiza trifida	Early Coralroot	SC
Cryptogramma stelleri	Slender Cliff-brake	E

Litchfield County

Plants

Scientific Name	Common Name	Protection Status
Cuphea viscosissima	Blue Waxweed	SC*
Cypripedium parviflorum	Yellow Lady's-slipper	SC
Cypripedium reginae	Showy Lady's-slipper	E
Dalibarda repens	Dew-drop	E
Desmodium glabellum	Dillen Tick-trefoil	SC
Desmodium humifusum	Trailing Tick-trefoil	SC
Dicentra canadensis	Squirrel-corn	T
Diplazium pycnocarpon	Narrow-leaved Glade Fern	E
Draba reptans	Whitlow-grass	SC
Dryopteris campyloptera	Mountain Wood-fern	E
Dryopteris goldiana	Goldie's Fern	SC
Eleocharis equisetoides	Horse-tail Spikerush	E
Elymus trachycaulus ssp. subsecundus	Slender Wheatgrass	SC
Elymus wiegandii	Wiegand's Wild Rice	SC
Equisetum pratense	Meadow Horsetail	E
Equisetum scirpoides	Dwarf Scouring Rush	E
Eriophorum vaginatum var. spissum	Hare's Tail	T
Galium labradoricum	Bog Bedstraw	E
Gaultheria hispidula	Creeping Snowberry	T
Gaylussacia dumosa var. bigeloviana	Dwarf Huckleberry	T
Gentiana quinquefolia	Stiff Gentian	E
Geranium bicknellii	Bicknell Northern Crane's-bill	SC*
Helianthemum propinquum	Low Frostweed	T
Hemicarpha micrantha	Dwarf Bulrush	E
Hepatica acutiloba	Sharp-lobed Hepatica	SC
Houstonia longifolia	Longleaf Bluet	E
Hydrocotyle umbellata	Water Pennywort	E
Hydrophyllum virginianum	Virginia Waterleaf	SC

Litchfield County

Plants

Scientific Name	Common Name	Protection Status
Hypericum pyramidatum	Great St. John's-wort	SC
Isanthus brachiatus	False Pennyroyal	E
Isotria medeoloides	Small Whorled Pogonia	E
Krigia biflora	Two-flowered Cynthia	SC
Ledum groenlandicum	Labrador Tea	T
Liatris scariosa var. novae-angliae	Blazing-star	SC
Linnaea borealis var. americana	Twinflower	E
Linum sulcatum	Yellow Flax	SC
Lygodium palmatum	Climbing Fern	SC
Lythrum alatum	Winged-loosestrife	E
Malaxis monophyllos	White Adder's-mouth	E
Malaxis unifolia	Green Adder's-mouth	E
Megalodonta beckii	Water-marigold	T
Milium effusum	Tall Millet-grass	SC*
Mimulus alatus	Winged Monkey-flower	SC
Mitella nuda	Naked Miterwort	SC
Moneses uniflora	One-flower Wintergreen	E
Myriophyllum alterniflorum	Slender Water-milfoil	E
Myriophyllum sibiricum	Northern Water-milfoil	T
Nuphar microphylla	Small Yellow Pond Lily	SC
Nymphaea odorata var. tuberosa	Water Lily	SC*
Onosmodium virginianum	Gravel-weed	E
Ophioglossum pusillum	Adder's Tongue	T
Oryzopsis pungens	Slender Mountain-ricegrass	SC
Oxalis violacea	Violet Wood-sorrel	SC
Panax quinquefolius	American Ginseng	SC
Panicum xanthophysum	Panic Grass	SC*

Litchfield County

Plants

Scientific Name	Common Name	Protection Status
Pellaea glabella	Smooth Cliff-brake	E
Petasites frigidus var. palmatus	Sweet Coltsfoot	T
Pinus resinosa	Red Pine	E
Plantago virginica	Hoary Plantain	SC
Platanthera blephariglottis	White-fringe Orchid	E
Platanthera dilatata	Tall White Bog Orchid	SC*
Platanthera flava	Pale Green Orchid	SC
Platanthera hookeri	Hooker Orchid	SC*
Platanthera orbiculata	Large Roundleaf Orchid	SC*
Podostemum ceratophyllum	Threadfoot	SC
Polanisia dodecandra	Clammy-weed	SC*
Polygala senega	Seneca Snakeroot	E
Populus heterophylla	Swamp Cottonwood	E
Potamogeton friesii	Fries' Pondweed	E
Potamogeton hillii	Hill's Pondweed	E
Potamogeton ogdenii	Ogden's Pondweed	E
Potamogeton strictifolius	Straight-leaf Pondweed	E
Potamogeton vaseyi	Vasey's Pondweed	E
Potentilla arguta	Tall Cinquefoil	SC
Potentilla tridentata	Three-toothed Cinquefoil	E
Pycnanthemum clinopodioides	Basil Mountain-mint	E
Pyrola secunda	One-sided Pyrola	SC*
Quercus macrocarpa	Bur Oak	SC
Ranunculus ambigens	Water-plantain Spearwort	E
Ranunculus pensylvanicus	Bristly Buttercup	SC*
Ranunculus sceleratus	Cursed Crowfoot	SC
Ranunculus subrigidus	White Water-crowfoot	SC
Rhynchospora capillacea	Capillary Beakrush	E

Litchfield County

Plants

Scientific Name	Common Name	Protection Status
Rhynchospora macrostachya	Beaked Rush	T
Ribes glandulosum	Skunk Currant	T
Ribes rotundifolium	Wild Currant	SC*
Ribes triste	Swamp Red Currant	E
Rubus cuneifolius	Sand Bramble	SC
Salix pedicellaris	Bog Willow	E
Salix serissima	Autumn Willow	SC
Scheuchzeria palustris	Pod Grass	E
Schizachne purpurascens	Purple Oat	SC
Scirpus acutus	Hard-stemmed Bulrush	T
Scirpus hudsonianus	Cotton Bulrush	SC*
Scirpus torreyi	Torrey's Bulrush	T
Scleria verticillata	Low Nutrush	SC*
Scutellaria leonardii	Small Skullcap	E
Senecio pauperculus	Ragwort	E
Senna hebecarpa	Wild Senna	SC
Silene stellata	Starry Champion	SC
Smilacina trifolia	Three-leaved False Solomon's-seal	T
Solidago ptarmicoides	Prairie Goldenrod	E
Solidago rigida	Stiff Goldenrod	E
Solidago rugosa var. sphagnophila	Early Wrinkle-leaved Goldenrod	SC*
Sparganium fluctuans	Floating Bur-reed	E
Sparganium minimum	Small Bur-reed	SC*
Sporobolus cryptandrus	Sand Dropseed	T
Sporobolus neglectus	Small Dropseed	E
Stellaria borealis	Northern Stitchwort	SC
Streptopus amplexifolius var. americanus	White Mandarin	T

Litchfield County

Plants

Scientific Name	Common Name	Protection Status
Taenidia integerrima	Yellow Pimpernel	E
Thuja occidentalis	Northern White Cedar	T
Trichomanes intricatum	Appalachian Gametophyte	SC
Triphora trianthophora	Nodding Pogonia	SC*
Trisetum spicatum var. molle	Spiked False Oats	SC*
Trollius laxus	Spreading Globeflower	T
Utricularia resupinata	Bladderwort	E
Uvularia grandiflora	Large-flowered Bellwort	E
Vaccinium myrtilloides	Velvetleaf Blueberry	SC*
Viola canadensis	Canada Violet	SC
Viola nephrophylla	Northern Bog Violet	SC
Viola renifolia var. brainerdii	Kidney-leaf White Violet	SC
Viola selkirkii	Great-spurred Violet	SC
Waldsteinia fragarioides	Barren Strawberry	SC
Xyris montana	Northern Yellow-eyed grass	T

Reptiles

Scientific Name	Common Name	Protection Status
Clemmys insculpta	Wood Turtle	SC
Clemmys muhlenbergii	Bog Turtle	E
Crotalus horridus	Timber Rattlesnake	E
Eumeces fasciatus	Five-lined Skink	T
Heterodon platirhinos	Eastern Hognose Snake	SC
Terrapene carolina	Eastern Box Turtle	SC
Thamnophis sauritus	Eastern Ribbon Snake	SC

E = Endangered, T = Threatened, SC = Special Concern, * Believed Extirpated

State of Connecticut
Department of Environmental Protection
Bureau of Natural Resources, Wildlife Division
79 Elm St., Hartford, CT 06106

STATE OF CONNECTICUT
DEPARTMENT OF ENVIRONMENTAL PROTECTION

EXHIBIT
IJ 15

Bureau of Natural Resources
Wildlife Division
79 Elm Street, Sixth Floor
Hartford, CT 06106
Natural Diversity Data Base

September 25, 2006

Ms. Gabriel North Seymour
200 Route 126
Falls Village, CT 06031

re: Beebe Hill Cell Tower Study Project in Canaan, Connecticut

Dear Ms. Seymour:

I have reviewed Natural Diversity Data Base maps and files regarding the area delineated on the map you provided for the Beebe Hill Cell Tower Study Project in Canaan, Connecticut. According to our information, there are no known extant populations of Federal or State Endangered, Threatened or Special Concern Species that occur at the site in question. However, your letter request information on state-listed species that may occur within three areas surrounding this project site. The first site is labeled Area A. The following species may occur within the boundaries of Area A:

Species Name	Common Name	State Status
Ribes triste	Swamp Red Current	Endangered
Petasites frigidus var. palmatus	Sweet Coltsfoot	Threatened
Passerculus sandwichensis	Savannah Sparrow	Special Concern

The following state-listed species are recorded from Area B (one-mile radius):

Scientific Name	Common Name	State Status
Petasites frigidus var. palmatus	Sweet Coltsfoot	Threatened
Hybomitra lurida	A Horse Fly	Special Concern
Euphyes dion	Sedge Skipper	Threatened
Sturnella magna	Eastern Meadowlark	Special Concern
Salix serissima	Autumn Willow	Special Concern
Lota lota	Burbot	Endangered
Passerculus sandwichensis	Savannah Sparrow	Special Concern
Aegolius acadicus	Northern Saw-whet Owl	Special Concern
Ribes triste	Swamp Red Currant	Endangered
Lythrum alatum	Winged-loosestrife	Endangered
Linnaea borealis var. americana	Twinflower	Endangered
Trollius laxus	Spreading Globeflower	Threatened
Petasites frigidus var. palmatus	Sweet Coltsfoot	Threatened
Mitella nuda	Naked Miterwort	Special Concern
Viola nephrophylla	Northern Bog Violet	Special Concern
Mitella nuda	Naked Miterwort	Special Concern
Quercus macrocarpa	Bur Oak	Special Concern

Carex formosa	Handsome Sedge	Special Concern
Carex castanea	Chestnut-colored Sedge	Endangered
Carex castanea	Chestnut-colored Sedge	Endangered
Cypripedium parviflorum	Yellow Lady's-slipper	Special Concern
Platanthera orbiculata	Large Roundleaf Orchid	Special Concern

The following state-listed species are included in Area C (two mile radius):

Scientific Name	Common Name	State Status
Petasites frigidus var. palmatus	Sweet Coltsfoot	Threatened
Hybomitra lurida	A Horse Fly	Special Concern
Hybomitra lurida	A Horse Fly	Special Concern
Euphyes dion	Sedge Skipper	Threatened
Sturnella magna	Eastern Meadowlark	Special Concern
Salix serissima	Autumn Willow	Special Concern
Trollius laxus	Spreading Globeflower	Threatened
Lota lota	Burbot	Endangered
Passerculus sandwichensis	Savannah Sparrow	Special Concern
Rana pipiens	Northern Leopard Frog	Special Concern
Ambystoma laterale	Blue-spotted Salamander	Threatened
Crotalus horridus	Timber Rattlesnake	Endangered
Ambystoma jeffersonianum	Jefferson Salamander	Special Concern
Aegolius acadicus	Northern Saw-whet Owl	Special Concern
Aegolius acadicus	Northern Saw-whet Owl	Special Concern
Circumneutral seepage swamp		N/A
Subacidic rocky summit/outcrop		N/A
Ribes triste	Swamp Red Currant	Endangered
Lythrum alatum	Winged-loosestrife	Endangered
Dryopteris goldiana	Goldie's Fern	Special Concern
Linnaea borealis var. americana	Twinflower	Endangered
Mitella nuda	Naked Miterwort	Special Concern
Trollius laxus	Spreading Globeflower	Threatened
Petasites frigidus var. palmatus	Sweet Coltsfoot	Threatened
Cardamine douglassii	Purple Cress	Special Concern
Mitella nuda	Naked Miterwort	Special Concern
Quercus macrocarpa	Bur Oak	Special Concern
Viola nephrophylla	Northern Bog Violet	Special Concern
Mitella nuda	Naked Miterwort	Special Concern
Quercus macrocarpa	Bur Oak	Special Concern
Draba reptans	Whitlow-grass	Special Concern
Petasites frigidus var. palmatus	Sweet Coltsfoot	Threatened
Anemone canadensis	Canada Anemone	Endangered
Plantago virginica	Hoary Plantain	Special Concern
Carex formosa	Handsome Sedge	Special Concern
Cypripedium parviflorum	Yellow Lady's-slipper	Special Concern
Carex castanea	Chestnut-colored Sedge	Endangered

Cypripedium reginae	Showy Lady's-slipper	Endangered
Potamogeton hillii	Hill's Pondweed	Endangered
Carex castanea	Chestnut-colored Sedge	Endangered
Schizachne purpurascens	Purple Oat	Special Concern
Scirpus acutus	Hard-stemmed Bulrush	Threatened
Cypripedium parviflorum	Yellow Lady's-slipper	Special Concern
Carex formosa	Handsome Sedge	Special Concern
Platanthera orbiculata	Large Roundleaf Orchid	Special Concern
Carex prairea	Prairie Sedge	Special Concern
Carex tuckermanii	Tuckerman Sedge	Special Concern
Equisetum scirpoides	Dwarf Scouring Rush	Endangered
Cryptogramma stelleri	Slender Cliff-brake	Endangered
Trollius laxus	Spreading Globeflower	Threatened
Amelanchier sanguinea	Roundleaf Shadbush	Endangered
Anemone canadensis	Canada Anemone	Endangered
Empidonax alnorum	Alder Flycatcher	Special Concern

If you require additional information on the bird species, please contact Ms. Jenny Dickson (DEP-Wildlife Division; 860-675-8130). For information on the reptiles, amphibians or invertebrate species you may wish to contact Ms. Julie Victoria (DEP-Wildlife; 860-642-7239). For information on the plants or significant natural communities, please contact our ecologist, Mr. Ken Metzler (DEP-Wildlife; 860-424-3585). For further information on the fish, please contact Mr. Donald Mysling (DEP-Fisheries; 860-567-8998).

Natural Diversity Data Base information includes all information regarding critical biological resources available to us at the time of the request. This information is a compilation of data collected over the years by the Natural Resources Center's Geological and Natural History Survey and cooperating units of DEP, private conservation groups and the scientific community. This information is not necessarily the result of comprehensive or site-specific field investigations. Consultations with the Data Base should not be substitutes for on-site surveys required for environmental assessments. Current research projects and new contributors continue to identify additional populations of species and locations of habitats of concern, as well as, enhance existing data. Such new information is incorporated into the Data Base as it becomes available.

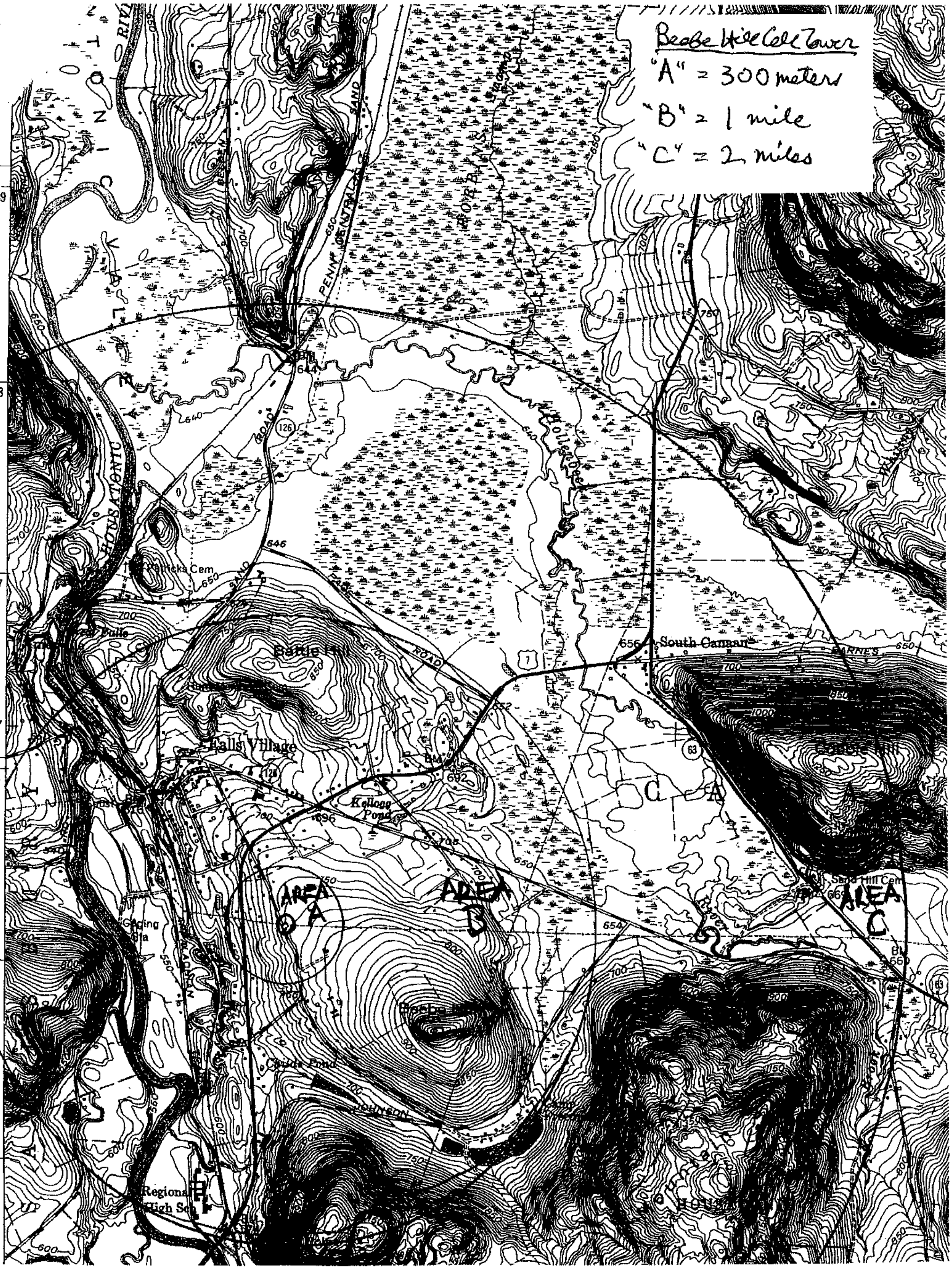
Please contact me if you have further questions at 424-3592. Thank you for consulting the Natural Diversity Data Base. Also be advised that this is a preliminary review and not a final determination. A more detailed review may be conducted as part of any subsequent environmental permit applications submitted to DEP for the proposed site.

Sincerely,

D.M. McKay

Dawn M. McKay
Biologist/Environmental Analyst

Cc: Jenny Dickson
Ken Metzler
Don Mysling
Julie Victoria
NDDB 14811



Beebe Hill Cell Tower
"A" = 300 meters
"B" = 1 mile
"C" = 2 miles
HOUSATONIC
South Canaan
Battle Hill
Falls Village
Kellogg Pond
Childs Pond
Sand Hill Cem
AREA A
AREA B
AREA C
(SHARON)
Regional High Sch

Blumberg No. 5135
EXHIBIT
IJ 16

John W. McNeely
Rte. 1, Box 281-A
Sharon, CT 06069
(860) 364-0650

9/26/06

To Whom It May Concern:

Re: Migratory and Breeding Birds within 2 miles of proposed celltower site on Beebe Hill in Falls Village, CT

My name is John McNeely. I have been studying birds for 45 years, and , during the 1980's gained international reputation for my work on the California Condor Recovery Team, initiating bird surveys in Cuba (in part to monitor over 45 species that nest in the NE US that migrate to Cuba), and award-winning documentary film production on various bird species. I observed many of the migrators while, for several years, I studied 12 plots in Housatonic State Forest in Area C. This was in collaboration with CT DEP's Migratory Bird Survey. All of the information in this report could be verified by the state's DEP Avian Biologist at Session Woods office in Harwinton.

Bird species of concern that nest within Areas A, B, and C include: Sharp-shinned Hawk, Whip-poor-will, Hedge Wren, Raven, Kestrel, Snipe, Bobolink, Alder Flycatcher, Meadowlark. Henslow's Sparrow and Golden-winged Warblers nested here recently but seemed to have dropped off the map.

Migratory Birds (some are breeding also)

Common Loon
Red-throated Loon
Horned Grebe
Pied-billed Grebe
Double-crested Cormorant
American Bittern
Least Bittern
Great Blue Heron
Great Egret
Cattle Egret
Green Heron
Black-crowned Night Heron
Canada Goose
Snow Goose
Wood Duck

Mallard
Black Duck
Gadwall
Pintail
American Wigeon
Shoveler
Blue-winged Teal
Green-winged Teal
Canvasback
Redhead Duck
Ring-necked Duck
Greater Scaup
Lesser Scaup
Common Goldeneye
Bufflehead

Hooded Merganser
Common Merganser
Red-breasted Merganser
Ruddy Duck
Turkey Vulture
Black Vulture
Harrier
Sharp-shinned Hawk
Cooper's Hawk
Goshawk
Red-shouldered Hawk
Broad-winged Hawk
Red-tailed Hawk
Rough-legged Hawk
Golden Eagle

Bald Eagle
Osprey
Merlin
Kestrel
Peregrine Falcon
Common Moorhen
Coot
Virginia Rail
Sora
Yellow Rail
Black-billed Plover
American Golden Plover
Semipalmated Plover
Killdeer
Greater Yellowlegs
Lesser Yellowlegs
Solitary Sandpiper
Spotted Sandpiper
Upland Sandpiper
Hudsonian Godwit
Dunlin
Pectoral Sandpiper
White-rumper Sandpiper
Semipalmated Sandpiper
Least Sandpiper
Stilt Sandpiper
Long-billed Dowitcher
Short-billed Dowticher
Woodcock
Snipe
Bonaparte's Gull
Ring-billed Gull
Herring Gull
Great Black-beaked Gull
Caspian Tern
Common Tern
Black Tern
Mourning Dove
Black-billed Cuckoo
Yellow-billed Cuckoo
Long-eared Owl
Short-eared Owl
Saw-whet Owl
Whip-poor-will
Nighthawk
Chimney Swift
Ruby-throated Hummingbird
Belted Kingfisher
Yellow-bellied Sansucker
Northern Flicker
Olive-sided Flycatcher
Wood Pewee
Acadian Flycatcher
Yellow-bellied Flycatcher
Willow Flycatcher
Alder Flycatcher
Least Flycatcher
Phoebe
Great-crested Flycatcher
Eastern Kingbird
Northern Shrike
Red-eyed Vireo
Warbling Vireo
Philadelphia Vireo
Yellow-throated Vireo
Blue-headed Vireo
American Crow
Horned Lark
Purple Martin
Rough-winged Swallow
Bank Swallow
Tree Swallow
Cliff Swallow
Barn Swallow
Brown Creeper
House Wren
Winter Wren
Sedge Wren
Marsh Wren
Golden-crowned Kinglet
Ruby-crowned Kinglet
Blue-gray Gnatcatcher
Bluebird
Robin
Wood Thrush
Veery
Swainson's Thrush
Grey-cheeked Thrush
Bicknell's Thrush
Hermit Thrush
Catbird
Brown Thrasher
American Pipit
Cedar Waxwing
Parula
Orange-crowned Warbler
Tennessee Warbler
Blue-winged Warbler
Golden-winged Warbler
(almost extinct)
Nashville Warbler
Yellow Warbler
Chestnut-sided Warbler
Magnolia Warbler
Cape May Warbler
Black-throated Blue Warbler
Cerulean Warbler
Blackburnian Warbler
Yellow-rumped Warbler
Black-throated Green Warbler
Prairie Warbler
Palm Warbler
Pine Warbler
Bay-breasted Warbler
Blackpoll Warbler
Worm-easting Warbler
Black and White Warbler
American Redstart
Ovenbird
Northern Waterthrush
Louisiana Waterthrush
Mourning Warbler
Yellow Throat
Wilson's Warbler
Canada Warbler
Hooded Warbler
Scarlet Tanager
Rose-breasted Grosbeak
Indigo Bunting
Eastern Towhee
Tree Sparrow
Field Sparrow
Chipping Sparrow
Grasshopper Sparrow
Sharp-tailed Sparrow
Savannah Sparrow
Vesper Sparrow
White-throated Sparrow

White-crowned Sparrow	Meadowlark	Pine Grosbeak
Fox Sparrow	Cowbird	Purple Finch
Song Sparrow	Red-winged Blackbird	Red Crossbill
Lincoln's Sparrow	Grackle	White-winged Crossbill
Swamp Sparrow	Baltimore Oriole	Redpoll
Dark-eyed Junco	Orchard Oriole	Pine Siskin
Lapland Longspur	Evening Grosbeak	Goldfinch
Snow Bunting		

In Areas A, B,and C I have either seen or heard most of these 206 species. Or they have been seen by various naturalists, primarily Audubon and Nature Conservancy personnel. Some species on my list have, to my knowledge, not been observed in Areas A, B, and C, but it is clear that those species do migrate through Areas A,B, and C when you consult any major reference such as David Sibley's *Sibley Guide to Birds* or Peterson's *Field Guide to the Birds.* Many species migrate at night, and, ironically, we get much of our data from strikes on other towers and buildings. As these species continue south from Falls Village, they run the gauntlet of many towers and buildings in the Greater New York metro area. A cell tower on Beebe Hill would only intensify the hazard.

John W. McNeely

STATE GEOLOGICAL AND NATURAL HISTORY SURVEY OF CONNECTICUT

DEPARTMENT OF ENVIRONMENTAL PROTECTION

The Atlas of Breeding Birds of Connecticut

EDITED BY LOUIS R. BEVIER

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Sponsored by the National Audubon Society and the Audubon Council of Connecticut

BULLETIN 113
1994
ISBN 0–942081–05–6

Blumberg No. 5136
EXHIBIT
IJ 17

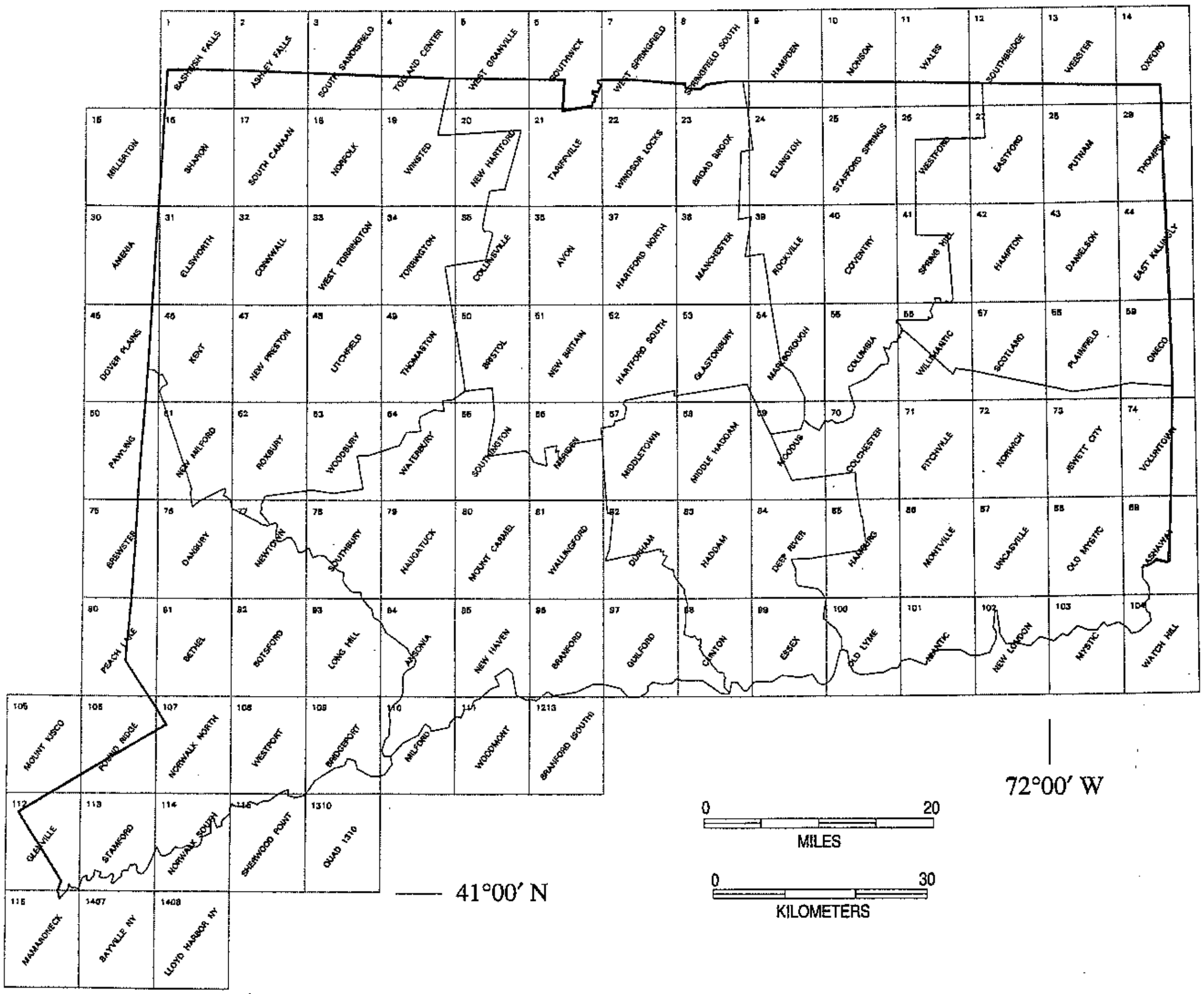


Figure 1. Index of atlas maps. The USGS quadrangles (7.5 minute series) were divided into six equal parts, termed blocks. These blocks were assigned a letter from A–F starting at the northwest corner of each quadrangle. Quadrangles are numbered as in the *Atlas of Connecticut Topographic Maps* (DEP 1992).

How to read the atlas maps

USGS Quadrangles (7.5 minute series) shown to the left were divided into six parts. **Blocks** are identified by the quadrangle number plus the letter assigned to each part of the map.

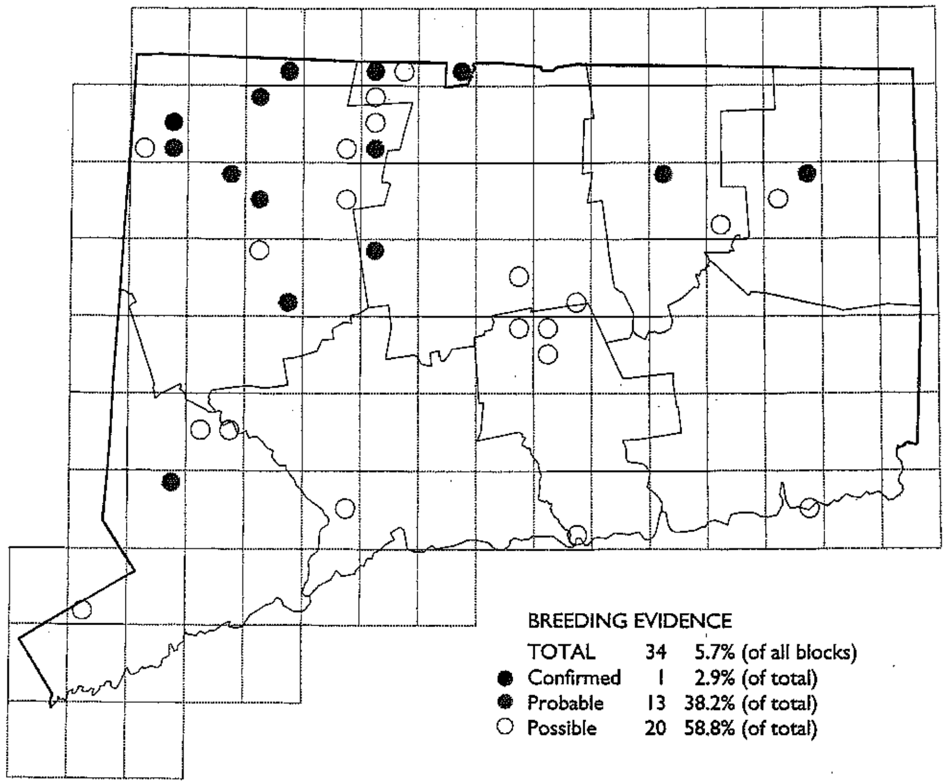
A	B
C	D
E	F

Breeding evidence symbols

- ● Confirmed
- ● Probable
- ○ Possible

The 5km × 5km square blocks are not shown within the quadrangle grid for each species map, but dots are always in the center of the blocks in which breeding evidence was reported.

American Bittern
Botaurus lentiginosus



This secretive bird of marshes and bogs is now a rare and local migratory breeder at interior marshes in Connecticut and has recently been designated as Endangered in the state. This species is more frequently encountered as a fall migrant in Connecticut, especially at coastal marshes; a few may linger late in fall or, more rarely, spend the winter. Spring migrants arrive in early April and are occasionally seen away from breeding localities through late May. The American Bittern breeds well north into Canada, mainly south of central British Columbia across to Newfoundland, and southward, locally, to Texas and northern Mexico; the species winters over much of the United States, parts of the West Indies, and Mexico (AOU 1983).

Habitat—Breeding in Connecticut is restricted to freshwater interior marshes with tall emergent vegetation, especially cattails and bulrushes. This species has nested in brackish marshes, such as at the Connecticut River mouth, but has not done so recently (Craig 1990). Broad, dense marshes are favored, although wet swales may occasionally be used for nesting provided there is dense cover. Nests may be constructed over water on a platform of bent cattail stems and leaves or, infrequently, built on dry ground at the margin of the marsh (Hancock and Elliott 1978). No more than one pair has been found occupying a single marsh in Connecticut recently. Nests with eggs have been found in late June in Connecticut (Sage et al. 1913).

Atlas results—The only confirmed breeding was in Sharon, but as detection of nests or young is difficult for this secretive species, the several probable localities in Litchfield County should be considered as likely nesting sites. Although several large marshes exist in northeastern Connecticut, only two blocks were reported there with probable breeding. A cluster of possible blocks in the vicinity of Cromwell indicate the strong likelihood of nesting in that area at Dead Man's Swamp, Cromwell Meadows, Wangunk Meadows, and Wethersfield Meadows.

Discussion—This species was formerly an uncommon to locally common breeder in extensive marshes of Connecticut. Although Merriam (1877) called the American Bittern a common summer resident, Sage et al. (1913) later described the species as rare in summer without stating whether the species had declined over the intervening years. More recently, the American Bittern has noticeably declined (Tate and Tate 1982), and Mackenzie (1961) attributed its scarcity in Guilford since the mid-1950s to draining of marshes.

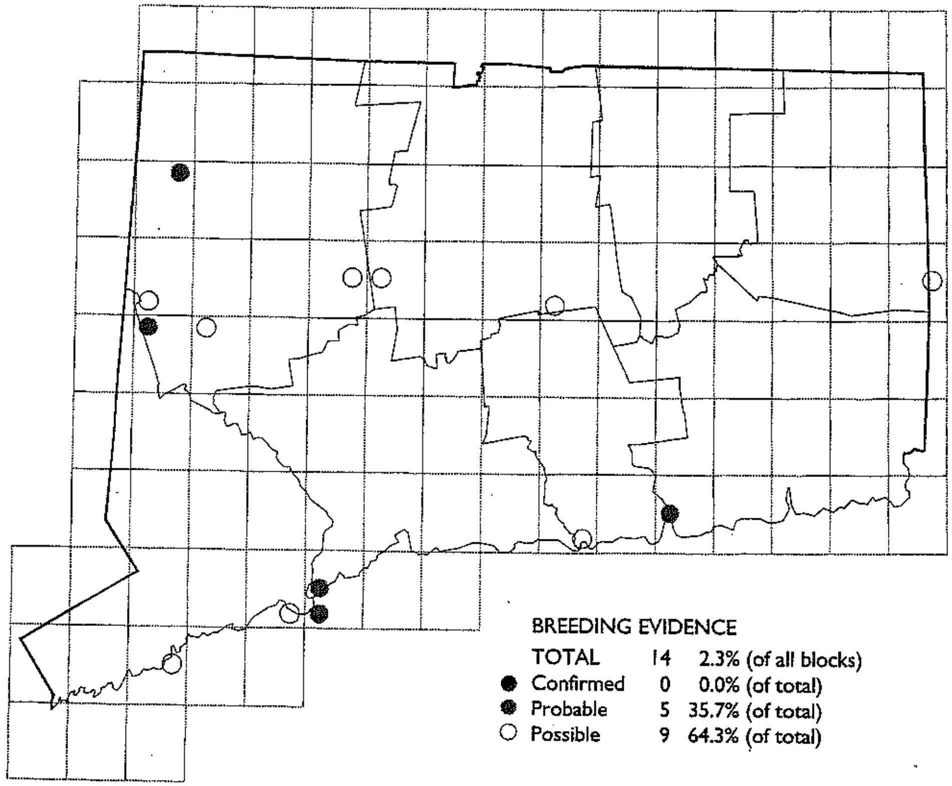
The American Bittern still occupies marshes in northwestern Connecticut and marshes along the Connecticut River. From 1971 to 1987, the only locality along the Connecticut River found to have American Bitterns consistently was Dead Man's Swamp, Cromwell (Craig 1990); its territorial pumping call has been heard there over the past several years (Kaplan and Mantlik 1990). Dowhan and Craig (1976) suggested that pesticides and other chemical pollutants accumulated through fish eaten by this species were a factor in the decline of the American Bittern. Loss of breeding habitat undoubtedly has contributed to its decline, especially considering the tremendous rate of draining and filling of swamps and marshes in the state during this century.

Louis R. Bevier

Northern Harrier
Circus cyaneus

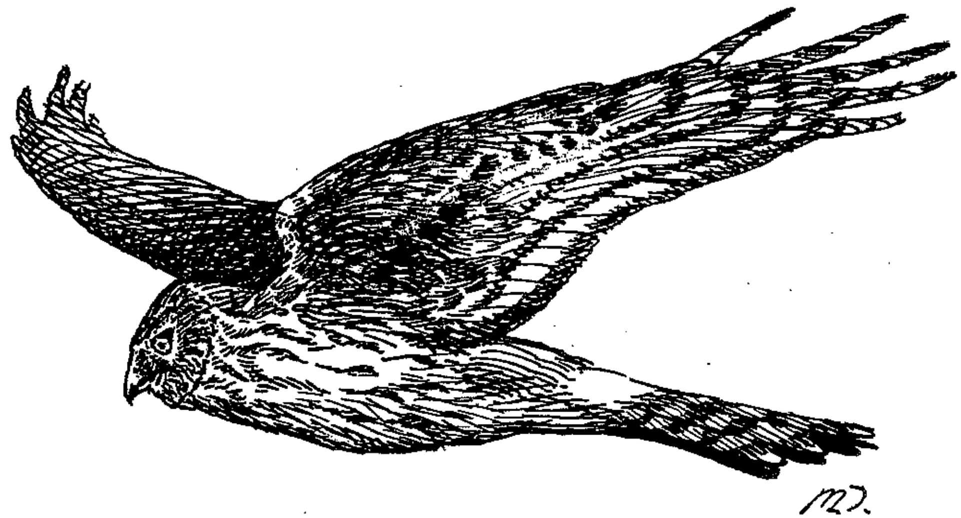
The Northern Harrier is an exceedingly scarce and sporadic breeder in Connecticut and has been designated as Endangered in the state. There is only one recent breeding record (see below). It is an uncommon to common migrant in fall, especially during peak migration days; spring migrants are much less common. A few individuals regularly may be observed in coastal marshes during winter.

North American breeders, subspecies *hudsonius*, of this circumpolar species winter south to Middle America, parts of the Caribbean, and northern South America. It is not known where breeding birds from southern New England migrate within this wintering range. The rich orange-buff underparts of the juvenal plumage is one of the defining characteristics of this subspecies (see Grant [1983] for a discussion on the separation of this subspecies from others).



Habitat—Typical nest sites in New England include extensive open freshwater or salt marshes, abandoned fields, old dune communities, extensive grasslands, and pastures. Similar areas are needed for foraging. The nest is a loosely built shallow cup lined with grasses and feathers, usually built on the ground. Harriers often forage by flying a few feet above an area and hovering when prey is seen or heard. Food consists of voles, birds, snakes, amphibians, and some insects.

Atlas results—Nearly half of the atlas records are from coastal marshes, such as near Lordship, Great Neck marsh, and along the mouth of the Connecticut River. Of the inland sites, six were in upland marshes in the northwestern part of the state.

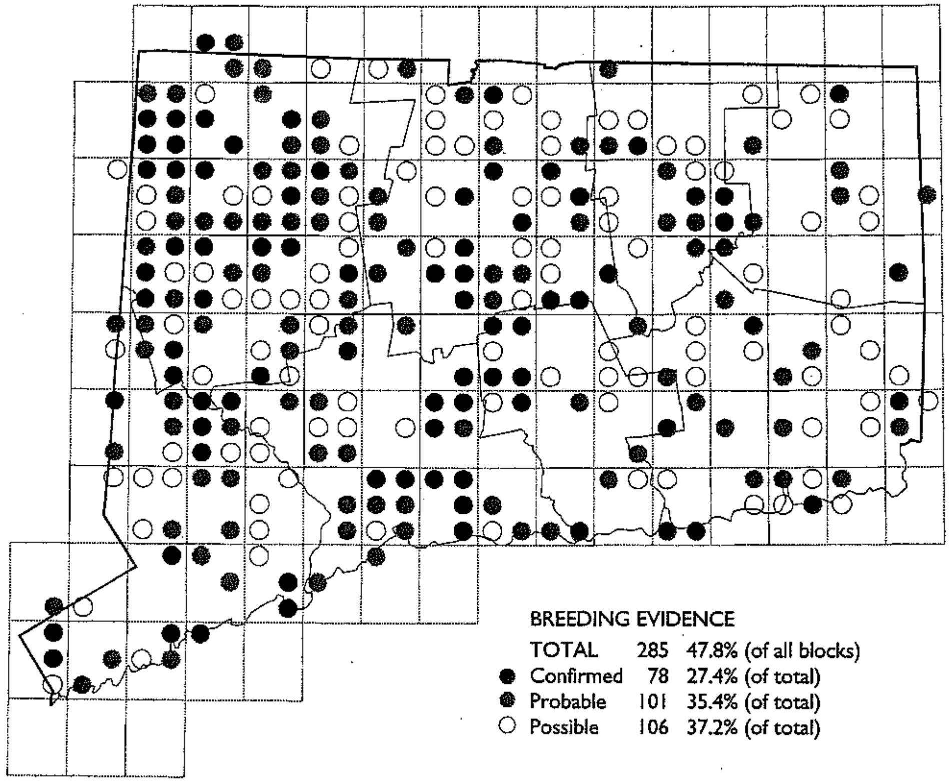


Discussion—Comparison with early accounts suggest that the Northern Harrier has sharply declined in Connecticut in this century. Linsley (1843), Bagg and Eliot (1937), Merriam (1877), and Sage et al. (1913) all considered it a common summer resident, especially along the coast, and an abundant coastal migrant. Sage et al. (1913) noted the earliest egg date for Connecticut as 9 May (1878) and the latest as 18 June (1884). A serious decline starting early in this century was apparently first noted by Morris (1901). The continent-wide decline of the Northern Harrier in North America was caused by indiscriminate shooting (Bagg and Eliot 1937), habitat loss due to development and reforestation (Bull 1964), and pesticides (Tate 1986, Serrentino and England 1989).

The decline of the Northern Harrier in the state has been attributed to habitat loss and pesticide poisoning (Dowhan and Craig 1976); disturbances during the nesting season might be a factor as well. The presence of a pair and the sighting of a juvenile attended by an adult female at Great Meadows, Lordship, in July 1991, is the only recent record of nesting (Charles Barnard *in litt.*). Although the Northern Harrier decline is linked with development, there are coastal and upland marshes within Connecticut that could support small numbers of nesting pairs, and if further habitat loss can be avoided, these areas might serve as recolonization centers for breeding harrier populations in Connecticut. Indeed, upland nesting sites are now being used in southeastern Massachusetts (Christiansen and Reinert 1990).

Dwight G. Smith and Arnold Devine

American Kestrel
Falco sparverius



The American Kestrel is an uncommon to fairly common breeder in Connecticut. A few are seen in the state throughout the year perching on wires or foraging along the grassy shoulders of roadways; kestrels are fairly common migrants, especially in fall. The species' breeding range extends from central Alaska and much of forested Canada southward to Mexico, locally to Nicaragua, and also throughout South America to Tierra del Fuego. Most northern birds (subspecies *sparverius*), including Connecticut breeders, withdraw to the south in winter, some as far as Panama (AOU 1957).

Habitat—The two primary requirements of American Kestrels are open terrain for hunting and cavities, particularly tree holes, for nesting. Among its favored habitats are grassland or shrubland at the edge of forest or open country with scattered trees; even urban open space is used if suitable perches and nest sites are available. In Connecticut, American Kestrels are usually seen around agricultural areas, airports, large parks, and power line rights-of-way. Kestrels most frequently capture prey on the ground or in short aerial attacks and either eat the item in its entirety or, during the breeding season, may cache it in one of several predetermined sites (Balgooyen 1976). In Connecticut, kestrels begin laying eggs in late April; natural tree cavities, flicker holes, nest boxes, or holes in buildings are most frequently used. The fledged young and adults often form family groups that remain together for several weeks before dispersing southward during the fall migration.

Atlas results—The species was recorded in all sections of Connecticut, although less densely in the eastern third of the state. The occurrence of suitable habitat throughout much of eastern Connecticut suggests the possibility that coverage was not as thorough there and that this falcon might be more widespread than indicated.

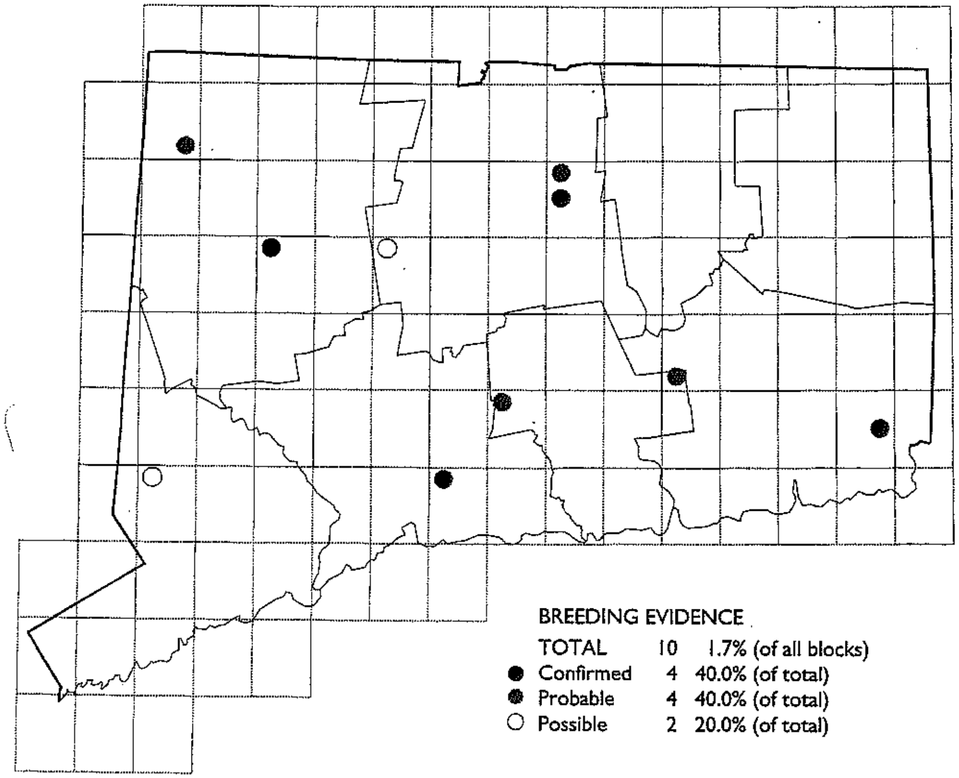
Discussion—The former status of the American Kestrel as a breeder in Connecticut is difficult to assess because its year-round presence hides a complex pattern of movements. They undoubtedly increased as farmland replaced forest and remained widespread until more recently. Sage et al. (1913) noted that they increased as a migrant at the turn of the century but characterized the breeding status as still comparatively rare, similar to what it was in the late 1800s (Merriam 1877). In contrast to Sage et al., this species was reported as a rare migrant in eastern Massachusetts between the 1880s and the 1920s but was said to be a common summer resident by the middle of the century (Griscom 1949). More recently, there is an impression of declining numbers in Connecticut. This might be due to the loss of open foraging areas following the extensive regrowth of forests and the loss of nest cavities now that dead trees are quickly cut for firewood. This trend may be at least partially mitigated by placement of nest boxes, which kestrels will readily utilize.

Dwight G. Smith and Arnold Devine

Common Moorhen
Gallinula chloropus

The Common Moorhen is a rare and sporadic migratory breeder, mainly at large fresh water marshes. It has been designated as Threatened in the state. Migrant birds may be found in wetlands across the state in spring, from late April on, or, more frequently, in autumn from late August to mid-October, after which occasional individuals linger until December, depending on when a hard freeze occurs. Breeders from the Northeast withdraw, for the most part, to the southern coastal Atlantic states, the coast of the Gulf of Mexico, or possibly farther south to Central America.

Habitat—Moorhens are typically found in large, deep-water marshes with tall, dense emergent vegetation surrounding the margins of the marsh. Cattail and cattail-reed swamps appear to be the favored habitats for the species in Connecticut, although so few nest that it is difficult to specify the precise requirements within the state. Dense vegetation is frequently used to shield movements, although the species does forage in open water. The nest is a basket-like affair usually hidden in cattails or emergent shrubs of a marsh. Snakes and raccoons may be the principal predators of moorhen eggs.



Atlas results—Confirmed nesting was determined in four blocks. In the northwest, the Common Moorhen was found nesting in the large fresh water wetland at the White Memorial Foundation. Along the Connecticut River, the extensive wetlands preserved in South Windsor at Station 43 provided nesting for at least one pair of moorhens. Other localities with confirmed breeding

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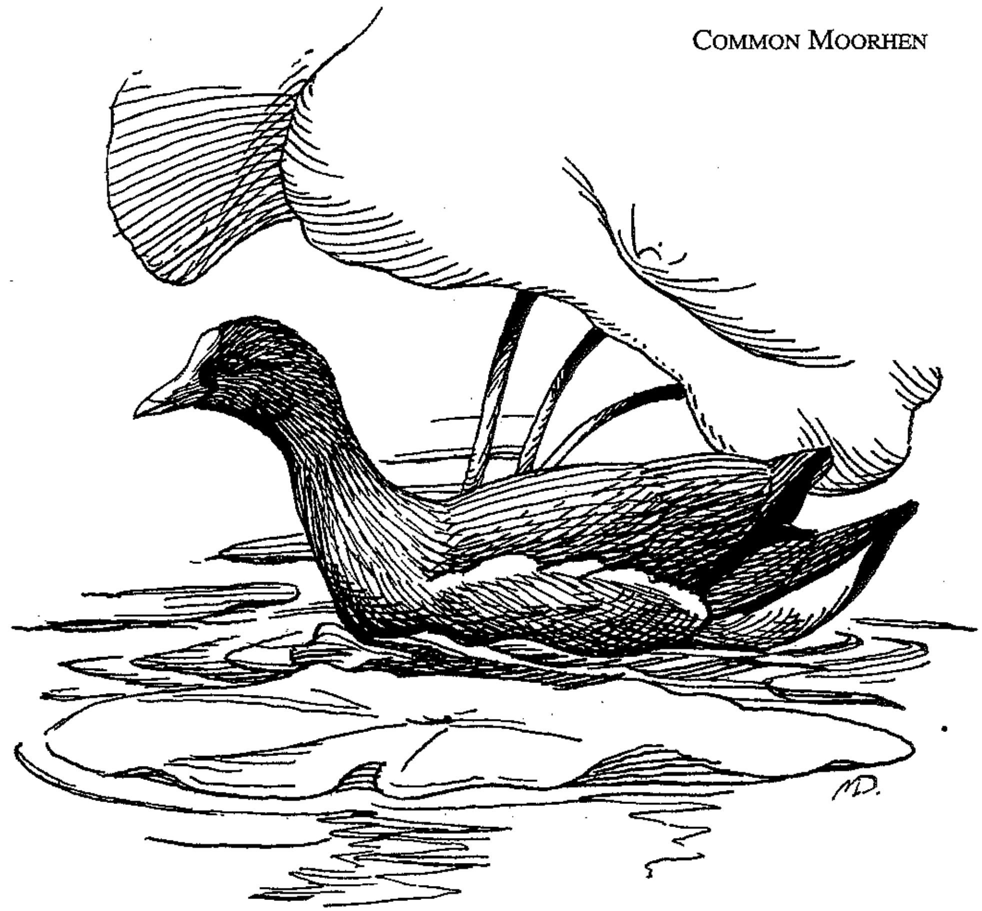


included Assekonk Swamp, North Stonington, and in North Haven. Probable breeding localities included the Miles Sanctuary, Sharon; Durham Meadows, Durham; and extreme northeastern East Haddam.

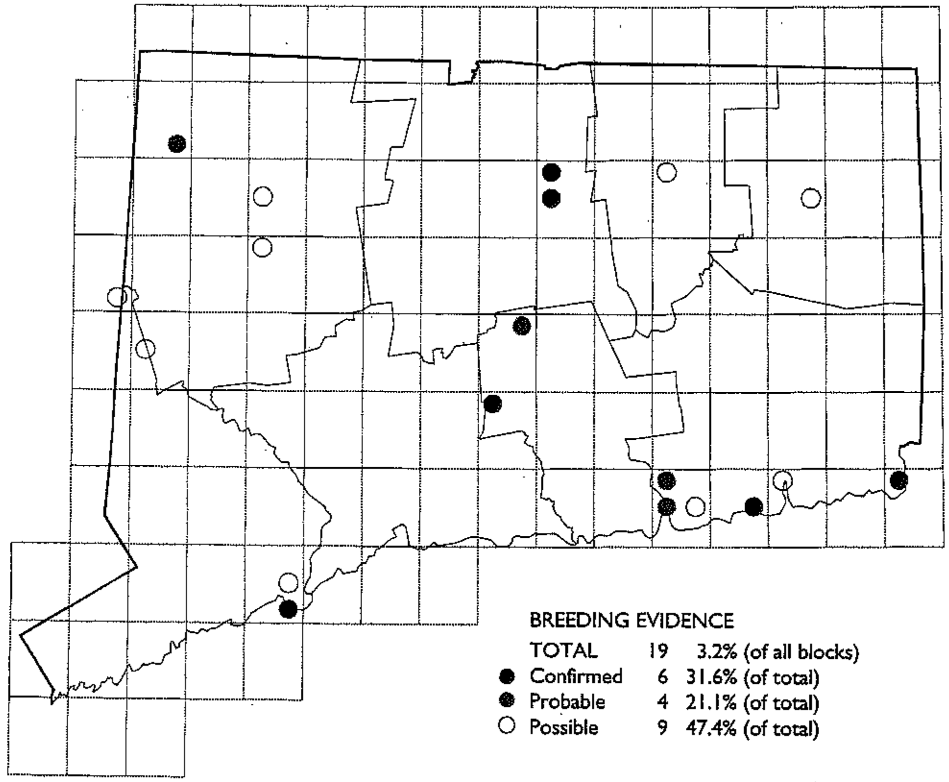
Discussion—The Common Moorhen appears to have been a rare migrant and summer visitor in Connecticut since ornithologists first visited the region, despite G. B. Grinnell's statement that this species was a rather common summer resident during the 1870s in the Milford area (Merriam 1877); this statement was called into question by Sage et al. (1913). It should be noted, however, that there is little quantitative information in existence for comparison with past populations in the state. The first report of a nest was in 1891 at Stratford (Lucas 1891), and the first reported nesting at South Windsor was in 1930 (Bagg and Eliot 1937). The species also reportedly nested at New Haven in 1940 (Bergstrom 1960), and again at Stratford in the 1970s (Hills 1983). During the 1980s, it nested at North Haven, Litchfield, South Windsor and North Stonington. Because the species breeds sporadically, a strategy of protecting only a few known localities could fail to assure continued breeding in the state, and although considered a game bird, its rarity surely makes the species unimportant to hunting, from which it should receive full protection. The draining and filling of large fresh water marshes in the state has certainly inhibited the potential for a breeding population to take hold.

Louis R. Bevier

Least Bittern
Ixobrychus exilis

This is perhaps the most secretive of our nesting herons, and it is frequently overlooked. Least Bitterns are migratory breeders in Connecticut, the population withdrawing to the southern United States in winter. Migrant Least Bitterns are rarely encountered, and most individuals seen or heard in Connecticut are at likely breeding localities. The subspecies breeding throughout the eastern United States is the nominate form, *exilis* (AOU 1957).

The familiar territorial call is a soft trebled sound, 'kwo-o-o,' but a frequently overlooked growling alarm call, 'gwaah,' can also be heard. The Least Bittern is listed as Threatened in Connecticut.



Habitat—Unlike the American Bittern, this species breeds both at coastal and at interior localities. Least Bitterns occur in estuarine salt and brackish marshes as well as freshwater marshes in Connecticut. Craig (1990) found the species most commonly in brackish cattail and cattail-reed dominated marshes on the Connecticut River.

Atlas results—Breeding was confirmed at South Windsor (Station 43), Durham Meadows, Barn Island in Stonington, Harkness State Park in Waterford, and at the margins of the Great Meadows marsh in Lordship, Stratford. In addition, two blocks near the mouth of the Connecticut River had probable breeding.

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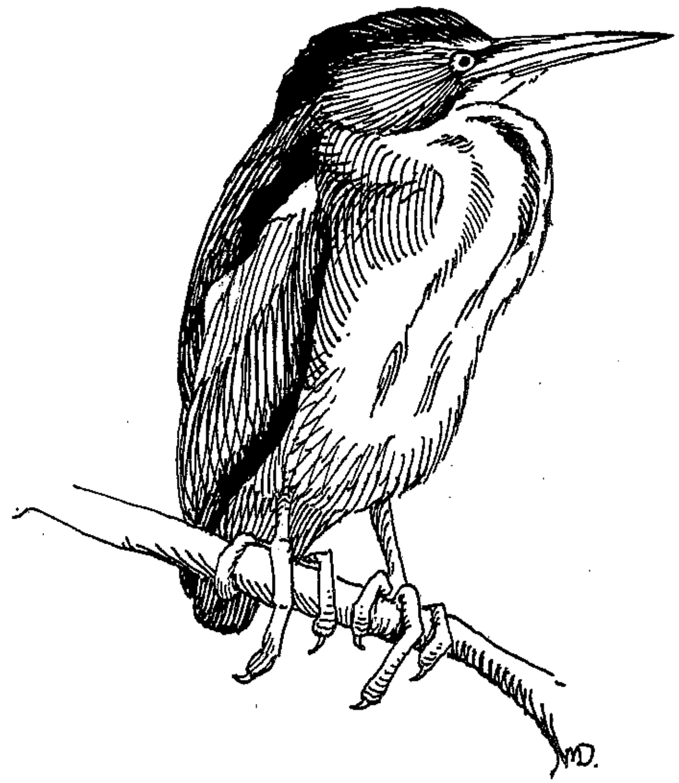
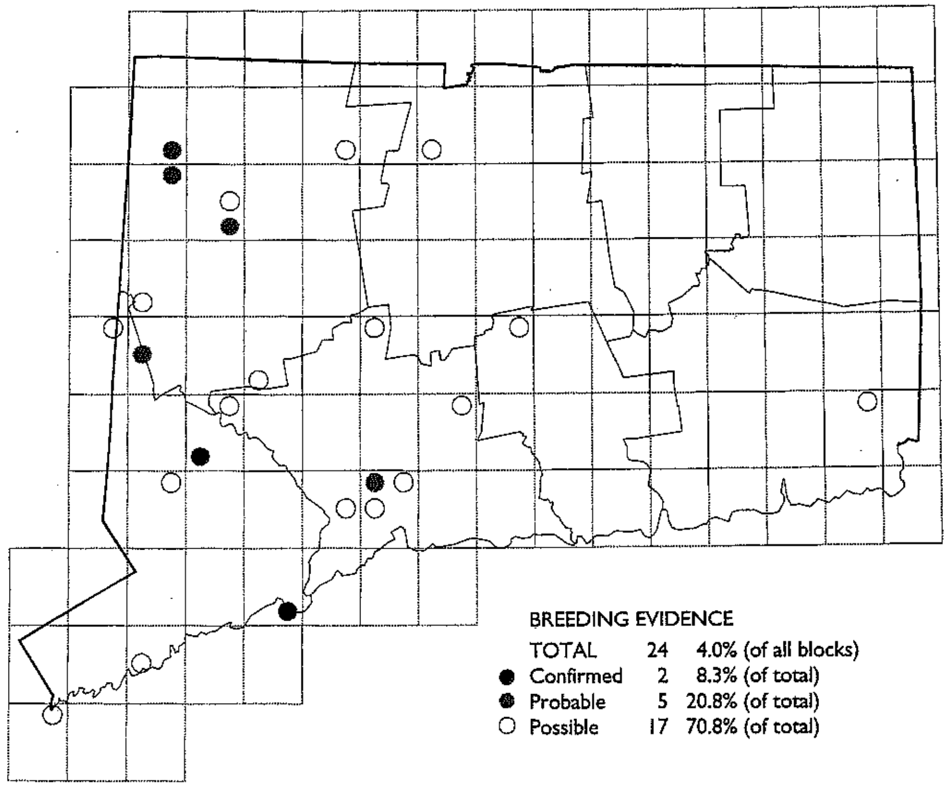


Discussion—Considering the tremendous loss of wetlands in the state and the fact that this was noted as a regularly occurring breeder by Merriam (1877), the species has almost certainly declined. Although comparison of the opinions of various authors is tenuous for such a secretive species, it is likely that a serious decline occurred in the late 1800s based on the comments of Sage et al. (1913), who described the species as rare. Although recent records indicate that the Least Bittern is not as scarce as it seems, the species is not abundant and is not found in many marshes that would otherwise appear suitable for nesting.

The Least Bittern was probably underreported due to its secretive behavior. Many small wetlands along the Connecticut River likely harbor several breeding pairs of Least Bittern, whereas along the coast, where observers tend to concentrate their efforts, the few localities found during this survey likely better represent the extent of breeding there. As with the American Bittern, the loss and degradation of wetlands in the state caused a reduction in the number of breeding individuals; unlike the American Bittern, however, the Least Bittern has remained a breeder coastally.

Louis R. Bevier

Pied-billed Grebe
Podilymbus podiceps



This is the only species of grebe that breeds in the state. The Pied-billed Grebe is a rare migratory breeder designated as an Endangered species in Connecticut. Breeding individuals usually arrive in Connecticut from late March through April depending on the severity of the winter and ice conditions on lakes, ponds, and marshes. Fall migrants are more numerous and widespread. The species is irregular and rare in the state during winter, most birds moving south of New England.

Habitat—The Pied-billed Grebe requires quiet ponds, lakes, and sluggish streams with extensive emergent vegetation for nesting. Cattail marshes and reed laden ponds are favored for nest sites. The nest is constructed with large bulky piles of plant materials overlain with a smaller, neater, more compact layer extending two to four inches above water. The entire structure is attached and anchored to emergent vegetation, usually in shallow water less than three feet deep. Floating nests are occasionally constructed over deep water.

Atlas results—Confirmed breeding was reported from only two blocks: at Great Meadows, Stratford, and at Newtown. Breeding was limited to western Connecticut, the entire eastern section of the state yielding only one possible breeding record. Since the years of the atlas survey, localities in northwestern Connecticut (e.g., Miles Sanctuary, Sharon) have supported suspected breeders, and the Stratford site still holds a single pair.

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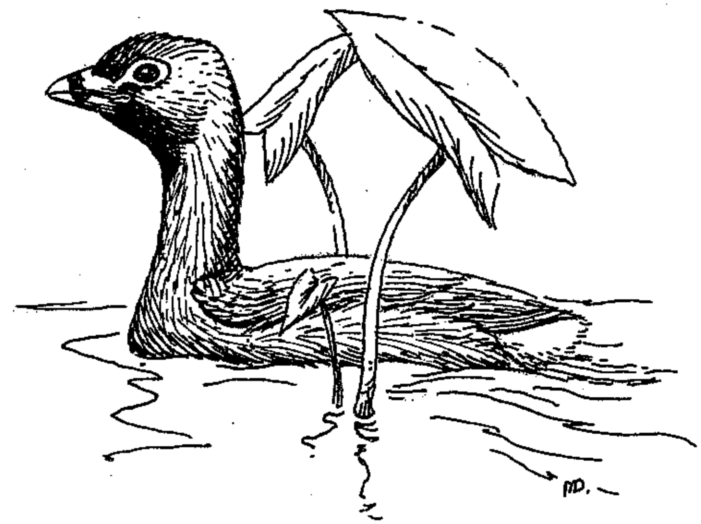
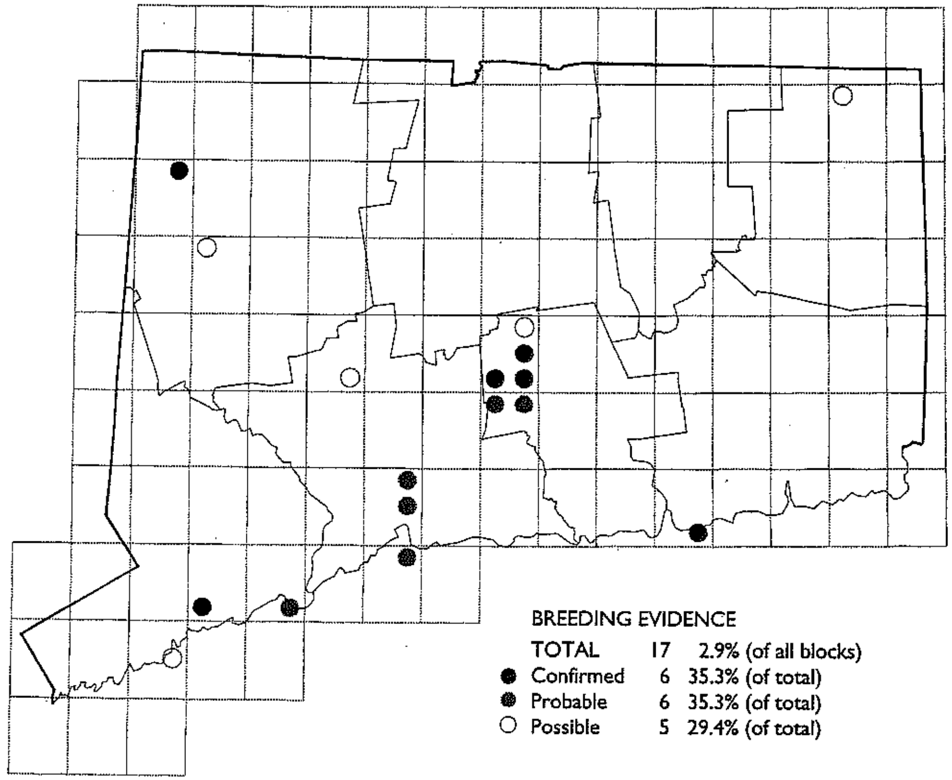


Discussion—This grebe has apparently always been a sparse breeder in Connecticut. Merriam (1877) and Samuels (1867) stated that it bred in Connecticut but gave no details. Bent (1919) described a nest observed in Canaan in 1913. Sage et al. (1913) noted that it was a common fall migrant and cited a probable breeding record near Wilton. They also reported summer observations of this grebe in Litchfield County. Bagg and Eliot (1937) indicated without details that it nested regularly in South Windsor. Mackenzie (1961) reported two nesting records from the Guilford area and wrote that L. B. Bishop had reported Pied-billed Grebes generally nested each summer at Lake Quonnipaug in Guilford.

Although the draining and filling of inland wetland habitat this century has obviously reduced potential nesting sites for the Pied-billed Grebe, we suspect that the breeding population is greater than the atlas data suggest. The Pied-billed Grebe is difficult to detect on its nesting grounds due to its secretive nature. In addition, growth of extensive emergent vegetation limits habitat visibility and accessibility to atlas researchers. However, the species responds readily to tape playback of its song, especially in the hours immediately preceding dawn. A comprehensive survey of potential nesting habitats coupled with playback censusing of these areas would clarify the extent of breeding in Connecticut.

Arnold Devine and Dwight G. Smith

Barn Owl
Tyto alba



The Barn Owl occurs throughout the tropical and temperate regions of the world. This distinctive tawny and white, "ghostlike" owl breeds widely across the United States. Susceptible to colder weather, this species shows a more localized distribution in the northern part of its range. Although widely distributed, the Barn Owl has declined in much of its range in the United States and was on the Blue List from 1972 to 1981; it was downgraded to Special Concern on this list in 1982 when the species had shown a positive response to nest box programs (Tate 1986). The Barn Owl is listed as Threatened in Connecticut.

Habitat—A remarkably adaptable species, the Barn Owl may utilize a variety of structures for nesting, often in close proximity to people. Known nest sites in Connecticut include church steeples, water tanks, barns, bridges, and buildings (both occupied and abandoned). Natural nest sites, such as tree hollows and caves, are found, but infrequently. Nest boxes may be used if placed near suitable foraging habitat, which includes extensive fields, marshes, or farm land that supports a rodent prey. Small mammals such as shrews, meadow mice, deer mice, house mice, and rats are favorite prey, but a variety of birds also are taken, especially in spring and summer. Nesting depends on prey availability and may occur from February through August. Normally, 5 to 7 eggs are laid in April or May, and young hatch in about a month. Several recent nests produced an average of 4.3 young (range 2–7 young; George Zepko pers. comm.).

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Atlas results—The Barn Owl occurs in much of Connecticut, except the northeast; breeding evidence, however, was recorded in only 17 blocks, just 6 confirmed. Additional nest sites have been found in Fairfield in 1978, Milford in 1980 and 1987–1989, Norwalk in 1992, and Greenwich in 1992. Most of these records are from the densely populated central lowlands and near the coast. Most nesting has been near Milford or Middletown; these might represent groups of related individuals as it is known that fledged young will colonize adjacent areas. The absence of Barn Owls from the highlands illustrates their intolerance of extended periods of cold and snow cover. Why the Barn Owl is not found elsewhere in the central lowlands or along the coast is less obvious, as suitable habitat exists.

Discussion—The Barn Owl has apparently increased in Connecticut during this century, being one of the several southern species to enter the Northeast during this period. Sage et al. (1913) called it a very rare visitor from the south. They compiled records from previous authors, listing 13 records from 1841 to 1911, plus an additional number from New London County. Most of these reports were from 1891 onward and included the first nest found in Connecticut—at the same locality in Winchester in 1892 and 1893. Bagg and Eliot (1937) cited nesting at Cromwell and South Windsor in the 1920s. Craig (1980) lists several towns with nesting: Fairfield, 1932–1933; Westport, 1944; Windsor, 1950; North Haven, 1952; and New Haven, 1960s. Although gradually increasing during this period, Barn Owls apparently remained scarce. Mackenzie (1961) listed only three recent sightings for Guilford between 1948 and 1958.

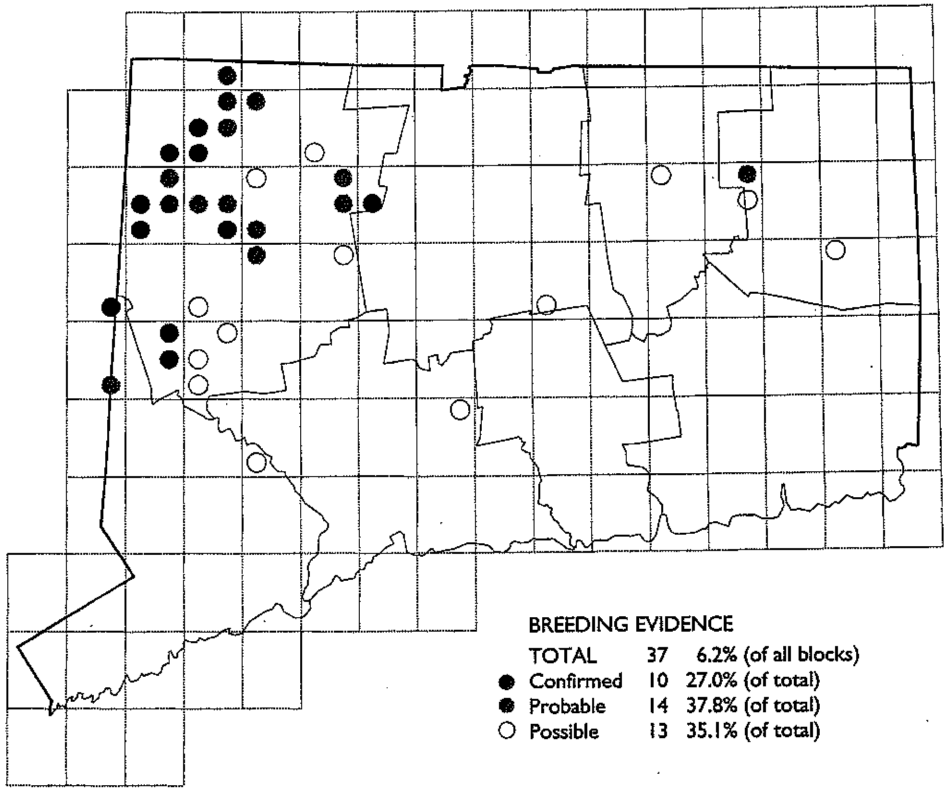
Its strictly nocturnal habits and its cyclical population have hindered attempts to assess accurately the numbers of this species in the state. A list of current and past nest sites as well as thorough survey of the state is needed.

Arnold Devine and Dwight G. Smith

Golden-winged Warbler
Vermivora chrysoptera

A migratory breeder, this species currently nests in Connecticut only locally in the northwest sector. It has historically occurred in small, local populations in the state, but such populations were formerly more widely distributed. Thus, it is listed as a Species of Special Concern in the state. The Golden-winged Warbler winters in Central America from Guatemala and the Yucatan Peninsula south to northernmost South America (AOU 1983). It migrates through eastern North America east of the Rocky Mountains (AOU 1983).

Habitat—Golden-winged Warblers typically breed in ephemeral, early successional habitats that support sparsely distributed deciduous plants. In Connecticut, such habitats consist primarily of abandoned farmlands that have scattered trees and shrubs and are bordered by second-growth deciduous forests.



The Golden-winged Warbler is a "fugitive species" that breeds in ephemeral habitats, quickly establishes populations, and equally as quickly declines as succession renders areas unsuitable for its breeding. This pattern of local colonization, expansion, and subsequent extirpation pertains well to Golden-winged Warblers breeding in Connecticut.

The exact habitat requirements of this species and the specific nature of the changes that make formerly appropriate habitat unsuitable are not clear. In Connecticut, Golden-winged Warblers typically breed in open, grassy areas with comparatively few trees and typical early successional plants, such as birches. This kind of habitat develops within 10 years of the

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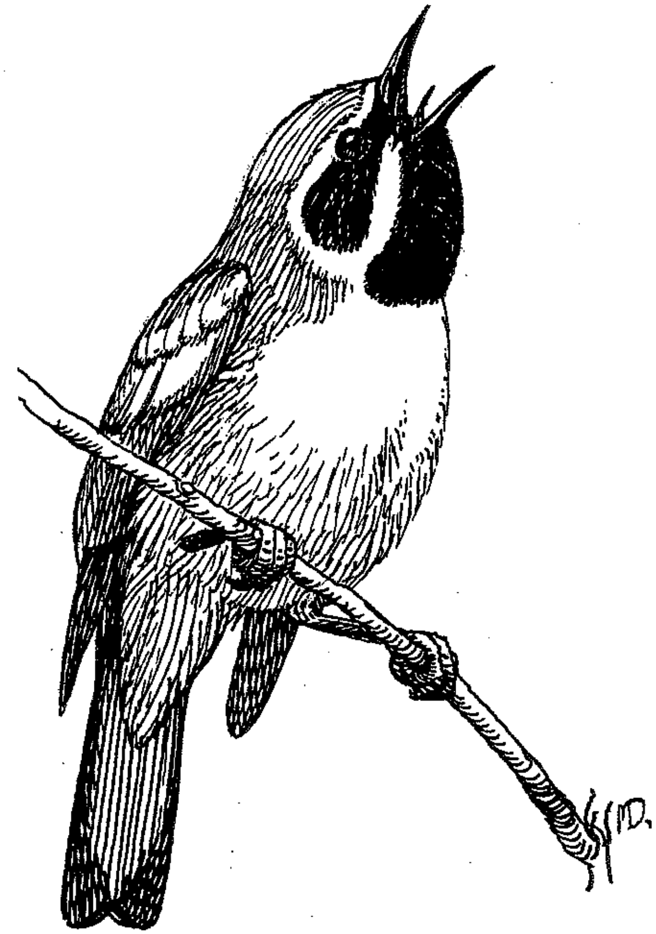
abandonment of agricultural lands and was more widespread formerly, as agricultural lands returned to deciduous forest. Suitable habitat usually lasts for only a few years, after which trees and shrubs become more dense and second-growth deciduous forest develops. When succession is slowed or reset by events such as flooding or fire, suitable habitat for Golden-winged Warblers may remain for longer periods of time.

Atlas results—During the atlas period, Golden-winged Warblers were recorded in barely 6% of the blocks. Over three-quarters of the blocks from which this species was recorded are in northwestern Connecticut, and the only confirmed breeding records were from northwestern blocks. The most records came from the Sharon, Kent, New Milford, and Torrington areas.

Discussion—The historical status of this species in Connecticut is reviewed by Gill (1980) and Bledsoe (1985). Before the mid-1800s, the Golden-winged Warbler was considered a rare migrant in Connecticut. The first recorded breeding, at Suffield in 1876 (Merriam 1877), was followed in the late 1800s by observations of scattered, localized populations in both northern and southern Connecticut. Many of these populations expanded rapidly and subsequently contracted, a pattern typical of this species throughout its breeding distribution. From roughly 1920 to 1970, Golden-winged Warblers bred only in the northern two-thirds of the state. Since 1970, nesting in Connecticut has been recorded regularly only in the northwest sector. (See the account of Blue-winged × Golden-winged Warblers for details about the hybridization of these species.) Elsewhere, fewer than 10 blocks have supported this species. Nearly all of these observations pertained to birds that were considered only as possible breeders. In the northeast sector of the state, where small populations existed during the mid-1900s, Golden-winged Warblers were observed in only three blocks. The atlas results indicate that the localized populations which existed away from the northwest sector in the 1960s and early 1970s have contracted since then and may no longer be extant.



Anthony H. Bledsoe

Blumberg No. 5136
EXHIBIT
IJ 18

WILDLIFE IN CONNECTICUT

ENDANGERED AND THREATENED SPECIES SERIES

AMERICAN BITTERN

Botaurus lentiginosus

ENDANGERED

ENDANGERED

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Habitat: Freshwater and saltwater wetlands.
Weight: 1-2 pounds.
Length: 28 inches.
Wingspan: 42 inches.
Life Expectancy: Approximately 8 years of age.

Food: Frogs, salamanders, crayfish, water scorpions, diving beetles, dragonflies, killifish, pickerel, suckers, small eels, garter and water snakes, and occasionally voles.
Status: State endangered.

ᵈentification: Adult American bitterns are large, somewhat stocky birds with yellow eyes, rich brown upperparts, and a ıite throat that is offset by black streaks. Dark flight feathers are conspicuous on the wing tips when the birds are in ıight. The sexes are similar in appearance. Juvenile bitterns lack neck streaking.

ınge: American bitterns occur from Central British Columbia east to Newfoundland, south, locally, to the Gulf Coast nd west to southern California. They migrate south, but not to the extent that many other wetland birds do. The species ·nters in the southeastern and Gulf States and as far south as Central America and Cuba.

ᵗeproduction: American bitterns migrate north to breed from mid-April to early May. Unlike other members of the ·ron family, these birds are not colonial nesters. Male bitterns may be polygamous (more than 1 mate) and often have veral females nesting separately within their territory. Females choose the nest site in wetland areas, usually on the round or raised slightly on a platform of thick vegetation. The female also builds the nest, usually out of reeds, sedges ·d similar plant material. The nest is 6 to 13 inches high and 12 to 16 inches wide, The 2 to 5 elliptical, olive-buff to ıff-brown, slightly glossy eggs are laid at daily intervals.

·cubation begins when the first egg is laid and lasts for 24 to 29 days. The female is responsible for both incubation and nding the young. Young bitterns differ in size. They leave the nest after about two weeks but continue to be tended earby. Their age of independence and first flight is unknown.

ason for Decline: The primary reason for the decline in American bittern populations is loss of habitat. The marshes ıd swamps upon which this species depends have been drained and filled for a variety of human uses including oadways, housing and commercial developments.

istory in Connecticut: The American bittern was common in Connecticut during the late 1800s and it was a regular, ut not abundant, resident of freshwater wetlands in the early 1900s. It is currently considered a rare migrant and ommon nester, with only one confirmed Connecticut breeding location reported in the last decade.

nteresting Facts: The American bittern, like many other herons, is solitary and moves slowly and secretively through ıse marsh vegetation. Bitterns are most active at dusk and through the night. If alarmed, a bittern will stand motionless ıth its bill pointed straight up and its body contracted. This habit gave the bird its regional names of sky-gazer, look-up nd stake-bird. Bitterns that flush when startled give a nasal "haink" call and beat their wings rapidly as they take flight.

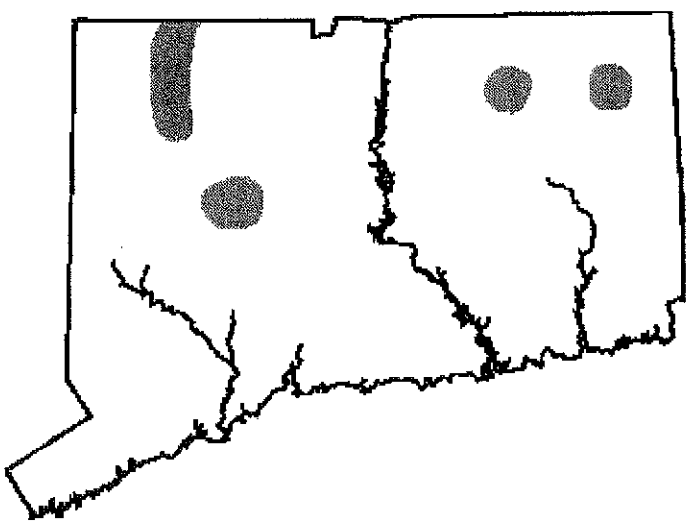
ıtterns call most often in the spring. A loud, guttural "pump-er-wink" is usually heard at dusk and gets its booming uality from a specialized esophagus. This unique call has led to many other common names, including water-belcher, re drum and thunder pumper.

)uring the breeding season, the males perform a remarkable courtship walk displaying white fan-like ruffs raised over ir back and shoulders.

rotective Legislation: *Federal* - Migratory Bird Treaty Act of 1918. *State* - Connecticut General Statutes Sec. 26-311.

hat You Can Do: Support for strong wetland conservation legislation, along with water pollution control efforts, will elp protect the habitat of American bitterns.

Connecticut Range



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(rev. 12/99)

ast Edited January 2000

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CONNECTICUT DEPARTMENT OF ENVIRONMENTAL PROTECTION

Blumberg No. 5136
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WILDLIFE IN CONNECTICUT

ENDANGERED AND THREATENED SPECIES SERIES

PIED-BILLED GREBE

Podilymbus podiceps

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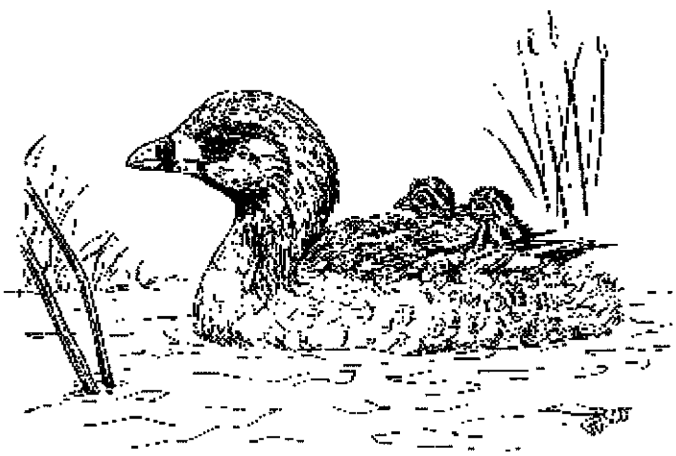

ENDANGERED

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Habitat: Streams, ponds, lakes and freshwater marshes. Winters in estuarine and marine habitats.
Weight: 10-18 ounces.
Length: 12-15 inches.
Wingspan: 23 inches.
Life Expectancy: 10-12 years.

Food: A variety of small fishes like sticklebacks and silversides; also damselfly and dragonfly nymphs, backswimmers, diving beetles and many other aquatic insects, snails, spiders, frogs, tadpoles, seeds and the soft parts of aquatic plants. Hatchlings are initially fed insects and then given small fishes as they grow.
Status: State endangered.

dentification: Adult pied-billed grebes are small, stocky and very brown. The belly is pale, and during the breeding ason, there is black on the pied-billed's chin and throat. During the summer, the short, blunt bill is encircled by a ɔad, black band. The pied-billed has lobed toes, which are characteristic of all grebes. However, unlike other grebes, ıe pied-billed shows almost no white on its wings during flight. Both sexes are similar in appearance.

ɜd-billed grebes rarely call except during the breeding and nesting season. The call is loud and cuckoo-like: "cuck, uck, cuck, cow-cow-cow, cow-ah, cow-ah."

ınge: The pied-billed grebe ranges from British Columbia east to Nova Scotia and south throughout the United States /herever habitat is suitable. The species winters south of the winter ice line on freshwater or saltwater (infrequently ɔng coastal Connecticut and Massachusetts).

eproduction: The breeding season begins in mid-May. The nest is built by both sexes in 3 to 7 days. It consists of both een and decaying vegetation and has a distinct hollow. The nest may vary in its location. A floating nest is usually in ɜ vegetation bordering open water. The nest may also be resting on the bottom in shallow water or it may be placed etween the stems of growing plants. The 4 to 7 smooth, elliptical eggs are almost white when first laid but become nest-ained as they are incubated. The eggs, which are usually laid at daily intervals, are incubated initially by the female. ıe male assists the female in incubating the eggs until they begin to hatch, about 23 days after they are laid, at which me the female resumes solitary incubation.

ıe downy, precocial nestlings have a variable rufous, black and white striping pattern. Patches of bare yellow skin are isible on the lores (area between the bill and the eyes) and crown. After hatching, the young follow the adults, often ing on their backs or clinging to their tails. The adults will sometimes feed the chicks while they ride on their backs d will even dive below the water's surface with the chicks aboard. It is fairly common for the pied-billed grebe to have sets of chicks a year.

ason for Decline: Pied-billed grebes nest in low numbers throughout their entire range. This, coupled with wetland egradation and loss, has resulted in a very small population. The species is declining throughout New England. In New mpshire, they are classified as endangered, while in Massachusetts they are threatened. Vermont lists the pied-billed be as a species of special concern and Rhode Island considers it to be extirpated (locally extinct).

story in Connecticut: The pied-billed grebe was never a common, abundant nester in Connecticut. Reports of nesting gan to decline throughout New England in the 1850s. Scattered nesting was recorded in southern Connecticut roughout the early 1900s. Since the late 1940s, pied-billed grebes have been reported in Connecticut most frequently ing the midwinter and early spring. Few recent breeding locations have been confirmed in the state.

nteresting Facts: Pied-billed grebes are generally solitary. They "hide" from intruders by sinking down into the water il only their head is visible. Grebes do not dive as deeply as loons, usually about 20 feet or less. Dives last for about seconds. Alarmed grebes dive so swiftly underwater that they have been called hell-diver and water witch. The birds ay swim underwater when frightened until they reach plants in a shallow area, where they will remain submerged, cept for their eyes and bill, until the perceived danger has passed.

ale pied-billed grebes often perform a territorial display with other males at the border of their territories. The males, h their heads held high and their bills up, turn away from each other and call. They then swing back to face each er.

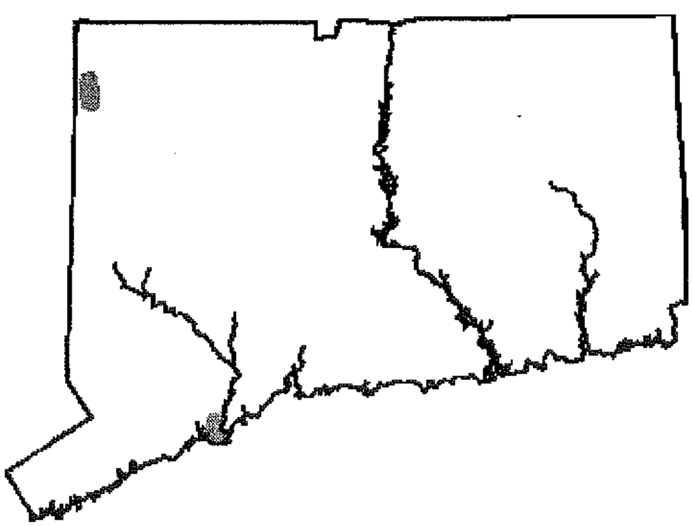
ebes have soft, thick, lustrous feathers. Their breast feathers were once used to decorate women's hats.

rotective Legislation: *Federal* - Migratory Bird Treaty Act of 1918. *State* - Connecticut General Statutes Sec. 26-311.

hat You Can Do: Support strong wetland protection legislation. Projects aimed at improving or restoring wetland reas for waterfowl will benefit the pied-billed grebe.

ce the nesting activities of the pied-billed grebe are often difficult to survey and monitor, any confirmed nests should e reported to the Wildlife Division to help increase our knowledge of the activities of these birds in Connecticut.

Connecticut Range



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·ev. 12/99)

Bureau of Natural Resources - Wildlife Division

·t Edited January 2000

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Blumberg No. 5136 EXHIBIT IJ 20

WILDLIFE IN CONNECTICUT

ENDANGERED AND THREATENED SPECIES SERIES

BARN OWL

Tyto alba

E N D A N G E R E D

E N D A N G E R E D

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Habitat: Open areas, such as grassy fields, old fields, wet meadows and wetland edges, around farms and rural towns. Daytime roost is usually an evergreen tree, belfry or barn.
Weight: Males, 14-19 ounces; females, 17-25 ounces.
Length: Males, 13-15 inches; females, 14-20 inches.
Wingspan: Males, 41-45 inches; females, 43-47 inches.

Life Expectancy: Few adults live beyond 3-4 years; high mortality the first year.
Food: Meadow voles, mice and shrews; also bats, skunks and various birds; frogs and large insects only if necessary.
Status: State endangered.

ntification: The barn owl has a white, heart-shaped facial disk, no ear tufts and long legs. The bird appears white m below and golden-brown from above, with black specks all over. The long wings fold beyond the tail and the legs re feathered. The sexes can be distinguished by differences in coloration and weight. Males usually have whiter breasts h fewer and smaller dark specks. Females are typically heavier and have more and larger dark specks. Chicks are ered with down when born, but 8 to 10 weeks later they acquire adult-like plumage.

nge: The barn owl is found on every continent except Antarctica. The species is considered partly migratory in the theastern United States, although many individuals remain there throughout the winter. Band recoveries indicate that me northeastern barn owls winter in Texas and the southeastern part of the country.

production: Barn owls are monogamous (one mate). They are not aggressive toward other barn owls and can nest ithin a half mile of other pairs. Barn owls are sexually mature at 1 year of age and, because they have a short lifespan, y breed only once or twice. Both natural and human-made sites are used for nesting and they are generally used eatedly by other barn owls throughout the years. Nest sites include tree cavities, barns, abandoned and occupied ldings, and chimneys. Males use a courtship call to show the female the nest site. Barn owls do not construct a nest; eggs are laid in a dark space surrounded by pellets. These brownish-black pellets, which are the regurgitated fur and one fragments of each meal, average about 2 inches in size and are produced twice a day.

e 5-11 eggs (average 4-6) are laid every other day. The female incubates the eggs for 30-34 days, starting when the irst egg is laid. Hatching occurs in the same order as the eggs were laid, so a gradation of ages and sizes can be observed a brood. In times of scarce food, the older and stronger young have a better chance of survival. Stronger, first-hatched stlings have been observed eating and trampling younger, later-hatched owls. The young are fed by both adults for pproximately 2 months. The adult male does most of the hunting and feeding.

ason for Decline: Land use changes, particularly the decrease in the number of farms, have contributed to the decline f this species. Not only has foraging habitat been reduced, but the increased use of rodent poisons has resulted in a aller food base. Natural nest sites in hollow trees are often limited, and human disturbance of the nest during ubation may cause nest abandonment. One common cause of mortality is predation of young barn owls by raccoons. ther mortality factors include exposure to harsh weather, electrocution by power lines, predation by dogs and great-ned owls, and accidental entanglement in farm and industrial machinery.

listory in Connecticut: The barn owl occurs in low numbers in Connecticut, probably because grasslands and mlands are declining. The historic population status of the barn owl in Connecticut is unknown because the species is ficult to locate. Barn owls are principally found along the coast and within the large river valleys of the state. Breeding as been confirmed in coastal areas and near Middletown, where there is an active monitoring and nest box program.

eresting Facts: The barn owl has exceptionally keen hearing and eyesight, making it a very effective hunter. It can ee during the day, but its relatively small eyes (for an owl) are directed forward and are better adapted for night vision. e ears are asymmetrical; one is level with the nostril and the other is higher, nearer the forehead. They are covered h feathered flaps that close for loud noises and open for soft sounds. The barn owl's hearing is so sharp that it can asily hunt for voles and shrews, which are often concealed from view as they travel in runways beneath the grass. A nily of 2 adults and 6 young may consume over 1,000 rodents during the 3-month nesting period.

arn owls make a wide variety of sounds. The most common adult sounds are alarm shrieks, conversational calls orter, less intense shrieks), and a rapid squeaking or ticking, which is associated with the pair. The rasping, food-gging call of the young can be heard almost continuously from soon after sunset until just before sunrise. The young lso hiss and bill-click when disturbed.

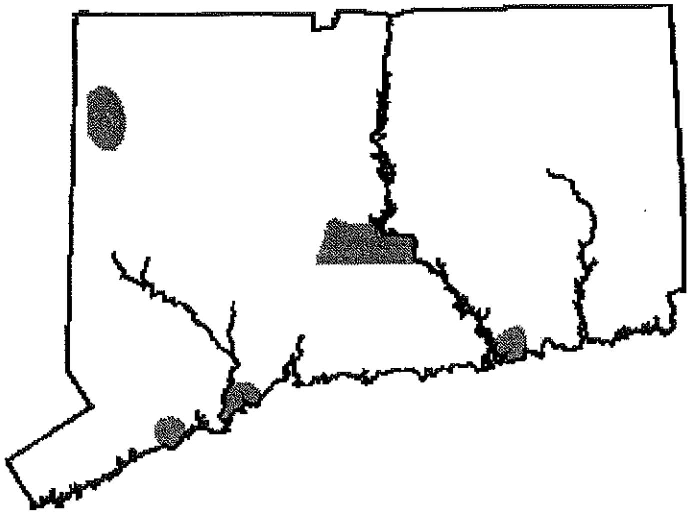
ile perched, the barn owl has a habit of lowering its head and swaying from side to side. The bird sleeps so soundly uring the day that it is difficult to wake it up until darkness arrives.

ner names for the barn owl are golden owl, white owl, monkey-faced owl and white-breasted barn owl.

otective Legislation: *Federal* - Migratory Bird Treaty Act of 1918. *State* - Connecticut General Statutes Sec. 26-311.

Vhat You Can Do: Learn more about owls by consulting references at your local library. Enjoy owls from a distance; not disturb adults or young, especially during the nesting season. If you live near suitable foraging habitat, provide st boxes for barn owls. Box plans are available from the Wildlife Division. Most important, encourage the protection f large areas of dense grass foraging habitats (at least 24-105 acres).

Connecticut Range



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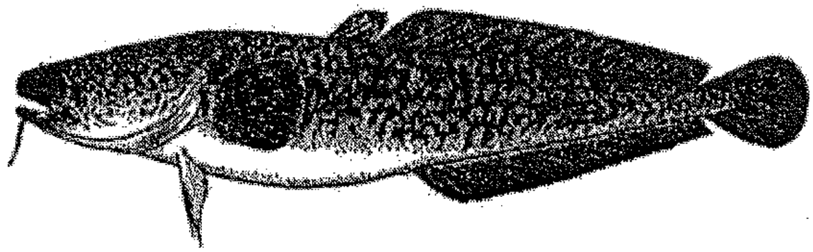
Alaska Department of
Fish & Game

www.adfg.state.ak.us

EXHIBIT
IJ21
Blumberg No. 5136

Burbot

The burbot (*Lota lota*) is often maligned as being too ugly to be worth an angler's time, However, hidden by its mottled green camouflage is a valuable food and recreational fish. The burbot is the only representative of the cod (Gadidae) family in fresh water in North America, and like its saltwater relatives, has mild-tasting white flesh.



Burbot are distributed in fresh waters throughout North America and Eurasia southward to about 40 degrees north, and occupy most large clear and glacial rivers and many lakes throughout Alaska. Burbot are known by a number of different names including lawyer, loache, ell pout, methy, lush, lingcod, and mud shark.

General description: The burbot has a thin, elongated body that tapers to a point near the tail. Its major distinguishing characteristics are a "chin whisker" or barbel, and dorsal and anal fins that run from the middle of the body almost to the tail. The tail is rounded rather than fork shaped. The mouth is quite large and contains numerous rows of small teeth that slant back toward the throat. Burbot have mottled olive-black or brown skin interspersed with yellow patches. Burbot appear to be scaleless but actually have small, almost microscopic scales.

Life history: Burbot are a relatively long-lived and slow-growing species. In Alaska, burbot older than 20 years are not uncommon. It takes burbot about six or seven years to reach a preferable size of about 18 inches. This is also the size at which most Alaska burbot spawn for the first time. Burbot spawn under the ice in late winter (February to March) and have been observed to mill together forming a large writhing ball while spawning. Eggs are very small, and an individual burbot can produce over a million eggs.

Young burbot feed mainly on insects and other invertebrates, but by the age of 5, burbot feed almost exclusively on fish. Adult burbot can appear sluggish, but they are voracious predators, feeding mostly at night. Once a burbot has captured a fish, it is reluctant to give it up. Its large mouth, strong jaw, and large number of inward slanting teeth account for the burbotÕs efficiency as a predator. Whitefish, sculpins, lampreys, and other burbot are common food items. Burbot also sometimes eat mice or shrews.

Fishing: Burbot can be caught in the summer as well as through the ice in the winter. In some areas set-lines or "trot-lines" are used. Individual set-line hooks must have a gap of greater than three-quarters of an inch and be set on the bottom. Set-lines must be inspected every 24 hours and identified with the angler's name and address. Seasons for the set-line use and maximum allowable number of hooks vary between areas, so check your regulations.

Burbot can also be caught using standard bait fishing techniques with hand-held rod. A 2/0 or 4/0 single hook baited with a chunk of fresh or frozen fish (smelt or whitefish) and a sinker located 18 to 24 inches above the hook is a good setup. Cast the bait out and allow the weight to rest on the bottom. In a river the bait will move around near the bottom in the current. When a consistent tug is felt, reel in your catch.

Most fishers like to keep only burbot larger than 18 inches. The best way to release any fish that has swallowed the hook is to just cut the line. The most popular fishing areas in Interior Alaska are large, glacial rivers such as the Yukon and Tanana rivers. Some of the best fishing occurs near rocky bluffs, in back eddies, and near the mouths of clear tributary streams. Burbot are also found in many lakes of Interior and Southcentral Alaska. However, the department has recently restricted burbot harvest in lakes due to declines in population abundance.

The easiest way to clean a burbot is to hang it by its head from a nail, cut around the skin near the neck, and pull the skin down to the tail using a pair of pliers. The fins can now be removed with pliers. The fish can be left whole with fins and head removed or it can be fileted. Your burbot is now ready to be fried, baked, or poached. No matter how it is cooked, the meat is flaky and a gourmet's delight.

Text: Rocky Holmes
Illustration: Source unknown
Revised and reprinted 1994

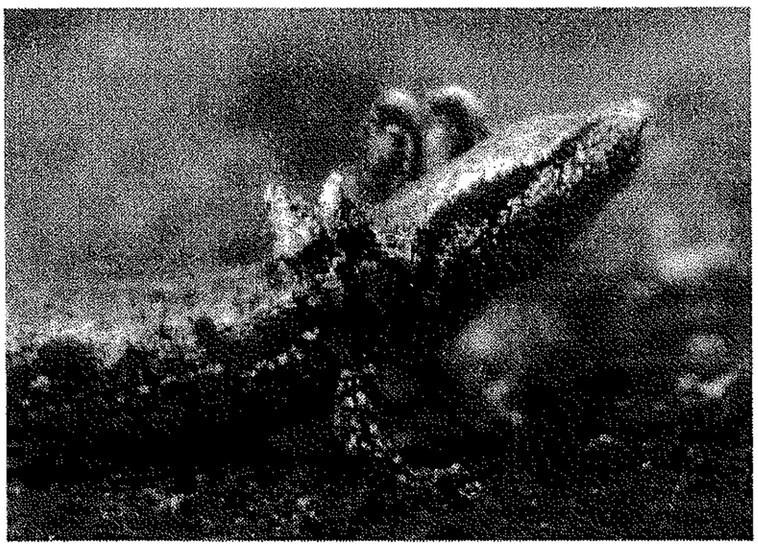
Blumberg No. 5136
EXHIBIT
IJ22

Rare Mudpuppies Found During Burbot Research Project

Written by Christopher Dixon, University of Connecticut

In 2005, the University of Connecticut (UCONN), supported by the federal State Wildlife Grants program administered by the DEP, embarked on a two-year research study of a state-endangered fish, the burbot (*Lota lota*). Fisheries biologists have documented the presence of burbot within two tributary watersheds of the Housatonic River drainage in northwestern Connecticut. Other than presence, little data existed on the habitat use and population demographics of the isolated fish populations and the overall conservation status was poorly known. The objectives of the project are to identify important characteristics of the stream environment that juvenile and adult burbot use and to describe the demography of the population. Part of the second goal includes the determination of whether any movement and migration patterns are occurring into and out of the two tributaries and the mainstem Housatonic River. This led the project researchers, Chris Dixon (graduate student) and Dr. Jason Vokoun (professor in the UCONN Department of Natural Resources), to discover another rare Connecticut salamander, the mudpuppy (*Necturus maculosus*). The Housatonic drainage locations are the first confirmed records of mudpuppies for the northwest corner of the state.

To capture the moving burbot, four baited hoop-net traps, two facing upstream and two facing downstream, were placed in the streams at five localities. Three of the trapping stations were set up near the mouths of the Blackberry River, Hollenbeck River, and Browns Brook. Another station was established upstream in the Hollenbeck River and the last station was located in the mainstem of the Housatonic River, approximately halfway between two tributaries, the Blackberry River and Hollenbeck River.


P. J. FL

During this sampling, which occurred in late fall to early winter 2005, four mudpuppies were captured within the hoop-nets. Two mudpuppies were captured on separate dates in the mouth of the Blackberry River, and the other two were captured in the mouth of the Hollenbeck River and in the mainstem Housatonic River, respectively. The mud puppies ranged in size from approximately 8.7 inches to 13.4 inches.

What Is a Mudpuppy?

A funny line from Conant and Collins (1991) A Field Guide to Reptiles and Amphibians of Eastern and Central North America reads: "North America boasts an assortment of big, bizarre salamanders that look more like a bad dream than live animals." Mudpuppies also are called waterdogs as there was a mistaken belief that these animals bark. These unique-looking salamanders keep their gills throughout their life. Scientists use the term neotenic (or permanent larvae) to describe this feature. In the warmer parts of the mudpuppy's range, the gills are big and bushy, while in the colder parts of its range, where the water holds more oxygen, the gills are smaller. Mudpuppies range from southern Quebec to southern Missouri. They can grow to be 8 to 13 inches long, live up to 20 years, are usually nocturnal, and are totally harmless. They are sensitive to chemical pollution and can be a good ecological indicator as to the health of the water system where they are found.

Julie Victoria, Wildlife Diversity Program

What Is a Burbot?

Burbot are the only freshwater members of the codfish family (Gadidae), which includes better known saltwater species, such as Atlantic cod and haddock. Burbot have an elongated body and are generally 6 to 14 inches long. They have a conspicuous single chin barbel, making them unique among Connecticut's freshwater fishes. Burbot grow much larger in lakes and rivers, where they can reach up to 25 inches long and live up to 16 years.

Mudpuppies -- Introduced or Native?

The mudpuppy (***Necturus m. maculosus***), a large aquatic salamander, has long been the subject of debate -- was it introduced to Connecticut or is it a native species? Babbitt, in his 1937 Amphibians of Connecticut, described the species as introduced. Klemens, in his 1993 Amphibians and Reptiles of Connecticut and Adjacent Regions, describes well the conflict among reference materials but also reports on the specimens collected in the 1800s and 1950s. Klemens concluded in his book that while the origin is unclear, if mudpuppies were to be "found in the Housatonic River, the entire question of the natural occurrence in southern New England would have to be examined." Now, here we are with four specimens captured in 2005 and all in the Housatonic River and its tributaries! The even better news is that researcher Chris Dixon, in his efforts to survey for burbot, seems to have inadvertently developed a good mudpuppy surveying technique!

While the Wildlife Division does not have any immediate plans to survey for mudpuppies, this intriguing new find and technique may prompt us to encourage interested students and herpetologists to help increase knowledge about this species.

Julie Victoria, Wildlife Diversity Program

CONNECTICUT DEPARTMENT OF ENVIRONMENTAL PROTECTION

Blumberg No. 5136 EXHIBIT IJ23

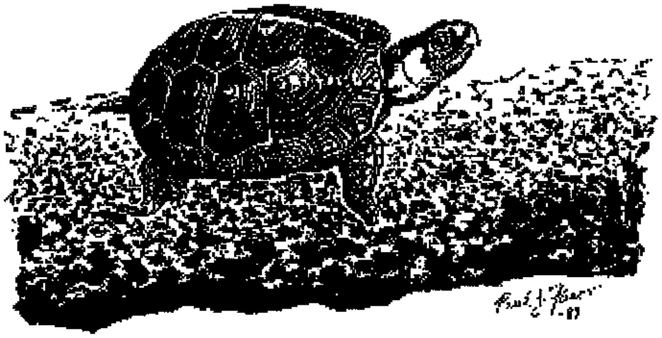
WILDLIFE IN CONNECTICUT

ENDANGERED AND THREATENED SPECIES SERIES

BOG TURTLE

Clemmys muhlenbergii

ENDANGERED



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ENDANGERED

Habitat: Calcareous (containing calcium carbonate, calcium or lime) wetlands such as open sphagnum bogs, wet meadows and wet pastures.
Weight: Approximately 4 ounces.
Length: 3-3.5 inches.

Life Expectancy: Although specifically unknown, the maximum age is estimated to be around 40 years.
Food: Seeds, berries, insects, slugs, worms, crayfish, frogs, snakes, snails and carrion.
Status: Federally threatened; state endangered.

d ntification: The bog turtle is the smallest of the 8 species of turtles found in Connecticut. It has an orange or yellow ead patch which is sometimes divided into 2 parts. The large scutes of the dark carapace, or upper shell, have yellow or dish centers.

ange: Bog turtles currently occur in scattered colonies in western Connecticut, western Massachusetts, and through v York, south to northeast Maryland, southern Virginia, western North Carolina and Georgia.

eproduction: Bog turtles breed in late April to early June after emerging from hibernation. Nests are usually in ocks or on sphagnum moss in sunny areas of a bog. The 2 to 5 (usually 2-3) eggs are laid from June to July and are on their own to develop and hatch. Incubation lasts for 7 to 8 weeks and hatching occurs from July to early eptember. In Connecticut, eggs may overwinter in the nest and hatch in the spring when there is an abundant food ply. The nests are often preyed on by skunks and raccoons. The young are only 1 inch long at hatching and are often n by a variety of birds and mammals. Bog turtles reach sexual maturity at 5 to 8 years of age.

son for Decline: Intensive development pressure in all portions of the bog turtle's range have caused the draining filling of many wetlands. Remaining wetlands have been isolated, resulting in the fragmentation of bog turtle opulations. These small populations cannot mix with others and only breed within themselves. The result is a loss of etic variation, which then reduces the population's ability to adapt to a changing environment. Bog turtles are very itive to changes in their environment, such as increased nutrification, altered drainage, vegetation changes or ollution.

tory in Connecticut: The bog turtle is the rarest turtle in Connecticut. Only small, isolated populations exist in the te and information on them is scant. Populations of bog turtles have been documented in 5 Connecticut towns. nconfirmed sightings and single specimens have been reported from several other towns between the Housatonic and onnecticut rivers. Collection for the pet trade has further depleted local populations. In 1973, the bog turtle was given tection by CITES, the Convention on International Trade in Endangered Species, and it is currently a candidate to be on the federal endangered species list. In Connecticut, it is against the law to remove any bog turtle, including eggs, om the wild.

eresting Facts: During the winter months, bog turtles hibernate underwater in deep areas of bogs in about 6 to 18 ches of mud. Immature turtles do not hibernate in deep mud until they are 2 to 3 years old. The turtles emerge from ernation in late March to April and may migrate short distances to feeding and breeding sites.

og turtles rely on an abundance of grassy or mossy cover and high humidity. Open, sunny areas where the turtles can k to raise their body temperature are also important. The turtles feed during the daylight hours; however, they are dom active during the hottest part of the day and are inactive on chilly mornings. Adult turtles are preyed on by accoons, skunks, foxes and dogs.

otective Legislation: *Federal* - Endangered Species Act of 1973. *State* - Connecticut General Statutes Sec. 26-311 nd Connecticut Regulation 26-66-14a.

hat You Can Do: Do not disturb or damage bog habitats. Bog turtles may not be collected from the wild, and they hould not be kept as pets. The pet trade has encouraged illegal capture of bog turtles in many areas of the country and only effectively be stopped by reducing the demand for bog turtles as pets.

Connecticut Range

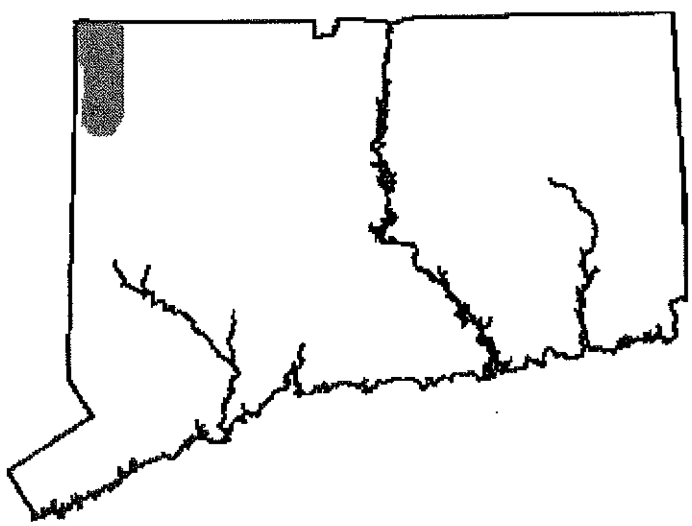

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EXHIBIT IJ24
Blumberg No. 5136

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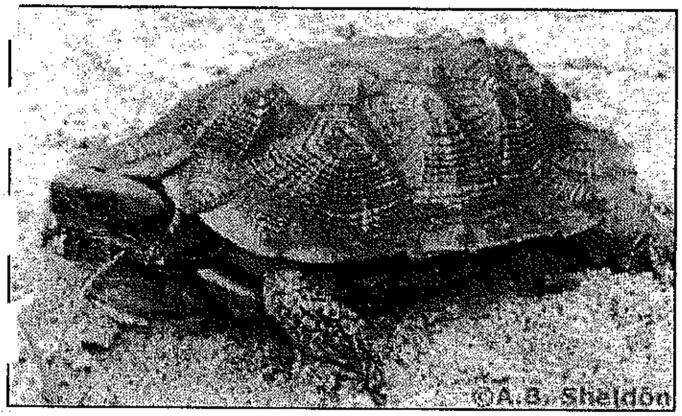
Wood Turtle
(*Clemmys insculpta*)



- **Legal Status in U.S.**: Unprotected
- **Legal Status in Wisconsin**: Threatened
- **Length**: 6-8 inches

Description || Habits || Distribution || Breeding Biology || Current Status || Excerpt from the Animal Guide

For information on Wisconsin's turtles and lizards including an identification key and more, order your copy of *Turtles & Lizards of Wisconsin.*

Description

The name "wood" suits this medium-sized turtle. Each roundish segment of its six to eight-inch shell looks like a woodgrained cross-section of a branch, complete with growth rings and yellow rays radiating from protruding blackflecked centers. Its brownish, sculptured shell is a fusion of chiseled pyramids, hence its species name "*insculpta*."

When the shell is dry, the grooves take on a spider web pattern. A noticeable midrib or keel runs front to back. The bottom shell is yellow with each segment blotched black along its side. On males, the lower shell is concave for mating. A black, blunt head and brown limbs are highlighted red or yellow on throat and soft connecting flesh. Males have long, thick tails with the cloacal opening, or anus, located outside the shell's edge. Females have slighter tails with the cloacae opening within shell boundaries.

Habits

The wood turtle is also well-named because of its choice of habitat, but its genus, *Clemmys*, is known as the "pond turtles" group. Putting these together means the wood turtle is semi-aquatic, living along forested rivers and streams. Water pollution, irrigation, and forest erosion have tainted many of its former haunts.

Active by day, April to November, wood turtles are omnivorous and consume insects, mussels, carrion, berries, dandelions and other succulent herbs.

In late fall, wood turtles inhabit stream banks and hibernate over winter in large community burrows.

Distribution

Wood turtles were once found throughout the state, except in the southwestern-most portion. Today, small scattered populations exist in isolated habitat. This turtle's original North American range extended from Nova Scotia to eastern Minnesota, south to northeastern Iowa, east to Virginia and north to New York. It is now threatened or endangered in much of this range.

ı Wisconsin, wood turtles live mainly in and along moderate to fast flowing streams and rivers. When summer arrives, they forage in deciduous forests and open meadows adjacent to these rivers. Turtle ›xperts now believe that wood turtles may be less terrestrial than originally believed; some "woodys" may ıhabit rivers year round.

Breeding Biology

_ike ornate box turtles, wood turtles mature late and live as long as 58 years. They mate in spring and fall, in or out of water. Females dig nests in June on communal gravel sites along banks or railroad beds. Wood ırtles have been seen nesting along the Elroy-Sparta bike trail, formerly a railroad right-of-way.

But the nests don't always survive. Egg predation by skunks, raccoons and opossums is becoming a erious problem due to an increase in the number of these scavengers since human settlement.

If the nest makes it through, a clutch of 4 to 17 white, smooth eggs laid in June will hatch in September. Gray hatchlings look awkward with tiny bodies and oversized tails.

Current Status

ʒefore wood turtles were placed on Wisconsin's endangered species list in 1974, hundreds were taken om the wild each fall and sold to biological supply houses. One collector recalls taking over 100 from one stream bank in 1972. Today, no wood turtles are found there. Collecting for biological experiments and issection may also be threatening other Wisconsin reptiles and amphibians, as well as many of the /orld's primates. Commercial overharvesting did in the now extinct passenger pigeon; no one ever thought we'd run out.

;ollecting wood turtles for pets is another problem. The alert wood turtle is as quick as a rat in mastering a maze and it learns to become a responsive pet. But captive turtles are usually not given proper space and substrate to breed. This means lost wild wood turtles in the future. Highway deaths take an uncounted ıumber of "woodys." One stretch of road in northeastern Wisconsin often frequented by wood turtles is ıarked with a "turtle x-ing" sign. Not uncommonly, well-intentioned people find a turtle near the side of the road, think it lost and take it home. Instead, they should try to guess which side of the road the turtle wants o be on and set it down well away from the road. Watch out for flailing claws!

:xcerpt from
THE ENDANGERED AND THREATENED VERTEBRATE SPECIES
)F WISCONSIN

Learn more about this publication...

ʒtatus: State Threatened (1975).

Occurrence: Found primarily in the north and western two thirds half of Wisconsin.

Aid to ID: Medium sized semi-terrestrial turtle. The dull brown carapace (upper shell) is very rough; each section of the shell is composed of concentric ridges (growth rings) that form an irregular pyramid. Plastron oottom shell) yellow with black blotches. Black head and dark brown extremities. Yellow to burnt orange kin on neck and in leg sockets.

labitat: Prefer lowland hardwood forests and open wet meadows associated with moderate to fast current treams and rivers with sand or gravel substrates. May forage in upland deciduous mesic forest and open meadows in summer. Use south facing sandy river banks or flat sandy soil openings adjacent to rivers for ıesting sites, including gravel banks, roadsides, fields, and meadows. Hatchling and juveniles prefer alder ıickets associated with shorelines and are considered critical habitat for this segment of the population.

Food Habits: Omnivorous. Diet includes: insects, mollusks, carrion, worms, blackberries, dandelions, nullen, sorrel, strawberries, grasses, sedges, filamentous algae, and mushrooms.

latural History:

Active: March to November. Active diurnally, especially in the morning. Solitary in late spring and summer when mostly terrestrial. Return to river in September and October. May aggregate in or near hibernation sites. Does not estivate.
Hibernation: In banks or bottoms of streams and rivers in winter.
Reproduction: Breed from March to November, but usually March to April and October to November. Reproductive activity (eg. courtship, copulation) is aquatic. Lay clutches of 4 to 18 eggs (avg. 8) in late May or June. Incubation approximately 70 days. Eggs hatch August to September. Sexual maturity reached in 10-14 years. This species is a communal nester and females from several miles of stream may congregate in a discrete, traditional site each year to nest, especially where nesting sites are scarce.

lanagement Considerations: Threats include heavy bank erosion, increased small mammal populations (nest predators), water pollution, and vehicular traffic. Use of riprap on river banks may preclude access to nesting sites, and plantings in sandy soil openings and on river banks may destroy nesting sites by shading hem out. Populations formerly reduced due to widespread collection by biological supply houses and the et trade. Poaching still occurs with this species. Wood turtles have a strong association with clear water and may benefit from watershed management aimed at reducing erosion and sedimentation. This species is vulnerable to very heavy nest predation because of communal nesting behavior. Predation exclusions nay prove successful in recovering this species. Electrical fencing has been somewhat effective when properly set up.

itream bank brushing, especially when done along both shorelines and over long distances, strongly disfavors this species, especially the younger age classes.

ıformation compiled from publications ER-513 89REV and ER-091.

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Robbins Swamp WMA

Lower - Map 3 of 3

Location: Canaan, North Canaan; Ashley Falls and South Canaan Quadrangles
Description: 739 acres; largely green timber swamp
Access: From Rt. 126, Rt. 7 and Barnes Rd.
Map Updated: 10/1/01
Note: This map depicts an approximation of property boundaries. Please obey all postings.

EXHIBIT IJ25

Blumberg No. 5136

SYMBOLS: Approximate Boundary | Private Land Inholding | P Parking Area

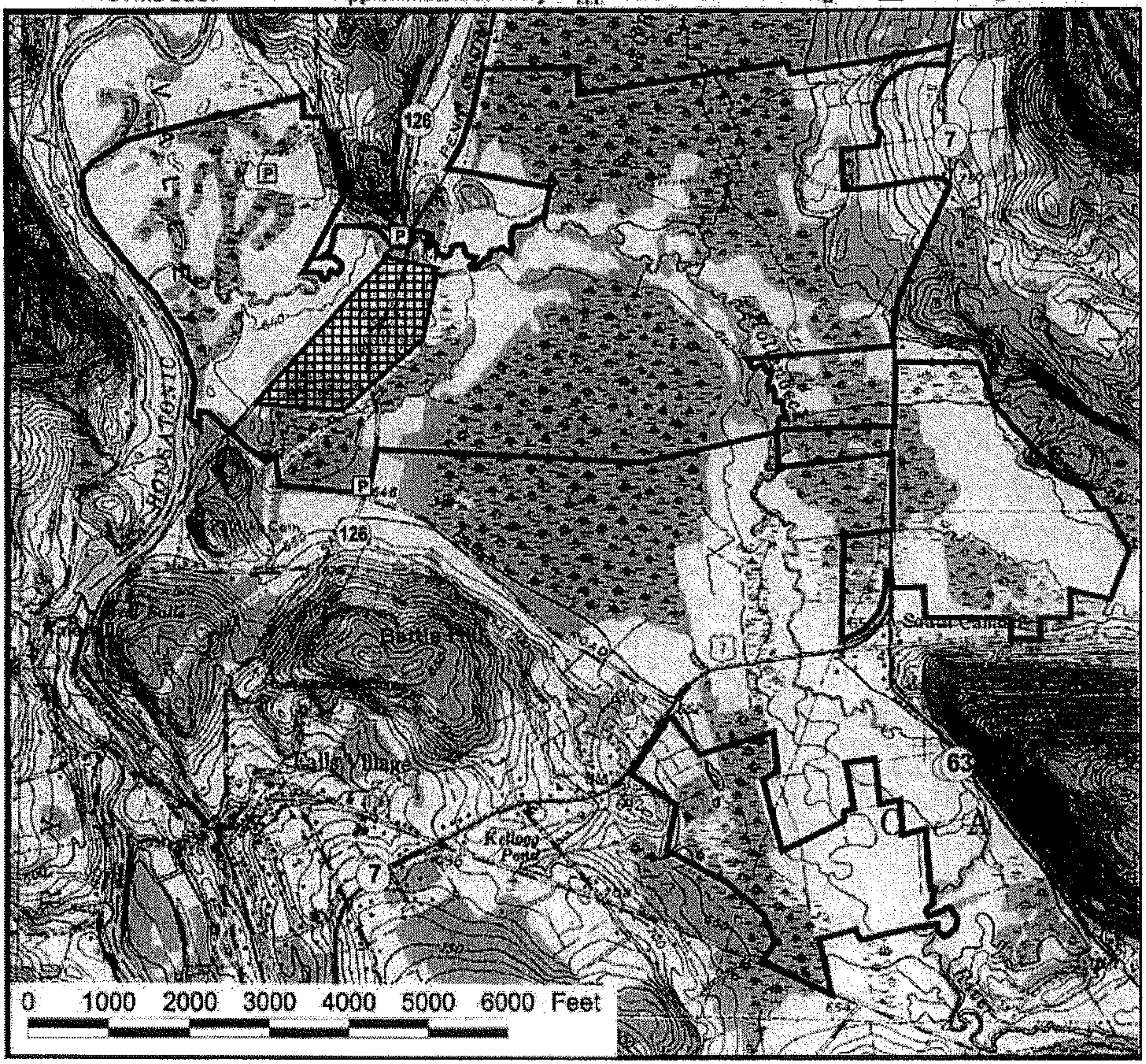

EXHIBIT
JJ 26

Toxicological & Environmental Chemistry, Apr.–June 2006; 88(2): 287–299

Taylor & Francis
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The incidence of electromagnetic pollution on the amphibian decline: Is this an important piece of the puzzle?

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(Received 26 October 2005)

Abstract
A bibliographical review on the possible effects of radiofrequency radiation (RFR) from wireless telecommunications on living organisms and its impact on amphibians is presented. The technical characteristics of this new technology and the scientific discoveries that are of interest in the study of their effects on wild fauna and amphibians are described. Electromagnetic pollution (in the microwave and in the radiofrequency range) is a possible cause for deformations and decline of some amphibian populations. Keeping in mind that amphibians are reliable bio-indicators, it is of great importance to carry out studies on the effects of this new type of contamination. Finally, some methodologies that could be useful to determine the adverse health effects are proposed.

Keywords: *Athermal effects, electromagnetic pollution, effects on amphibians, microwaves, phone masts*

Introduction

Amphibians are important components of the ecosystem and reliable bio-indicators; their moist skin, free of flakes, hair or feathers, is highly permeable to water chemicals (particularly larvae) and air pollutants (especially adults). Amphibian eggs are also directly exposed to chemicals and radiation. These characteristics make amphibians especially sensitive to environmental conditions, changes of temperature, precipitation or ultraviolet (UV) radiation and reliable monitors of local conditions [1].

A recent report from the International Union for Conservation of Nature (IUCN), prepared by 500 scientists from 60 countries, analyzed populations of 5743 amphibian

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ISSN 0277-2248 print/ISSN 1029-0486 online © 2006 Taylor & Francis
DOI: 10.1080/02772240600687200

species in the world and concluded that 1856 (32%) of them were considered threatened of extinction. Nine species have become extinct since 1980 and another 113 have not been observed in the recent years, and probably are also extinct [2]. The results demonstrate that amphibians are far more threatened than either birds or mammals, and the factors causing 'enigmatic' declines are driving the species toward extinction particularly rapidly. Unless these declines are quickly understood and reversed, hundreds of amphibian species can be expected to become extinct over the next few decades [3]. The disappearance of amphibians together with other organisms is a part of the global biodiversity crisis [4,5].

An associated phenomenon is the appearance of large numbers of deformed amphibians, with absent or extra limbs [5]. From 1995, at least 60 different species were affected with a high incidence of deformities, with several species affected in one place, in 46 states of United States and in regions of Japan, Canada, and several European countries [5,6]. The problem seems to have become more prevalent, with deformity rates of up to 25% in some populations, which is significantly higher than in previous decades [6].

The problem of deformities is complex because it is related to water quality, physiology, development, anatomy, and ecology [5]. The reduction in populations and the increase in deformities are a warning of serious environmental degradation [5].

Evidence exists that several populational declines are probably the result of complex interactions among several biotic and abiotic factors [1,4,7,8]. The proposed explanations are an increase of ultraviolet radiation (UV-B)[1,5,9–14]; chemical pollutants (pesticides, herbicides, fungicides, fertilizers, etc.) [5,15]; pathogen and parasites [1,6,16], destruction and alteration of habitat, changes in meteorological patterns (climatic change) [4,17], and introduced species [1,5].

The amphibian population declines are also occurring in relatively pristine places such as National Parks, or rural areas far from urban centers [3,14]. Humans and other animals can also be affected by the same environmental factors that damage amphibians [6].

A type of contamination whose effects on amphibians have not been studied up to now, is the electromagnetic pollution, especially microwaves and radiofrequencies from mobile telecommunications and radio station transmitters that will be discussed in this review. Before the 1990s, radiofrequencies were mainly from a few radio and television transmitters, located in remote areas and/or very high places. Since the introduction of wireless telecommunication in the 1990s, the rollout of phone networks has seen a massive increase in the electromagnetic contamination in cities and in the wilderness [18,19]. At the moment, new types of antennas are being investigated to reduce the power needed to establish communication [20,21]. Recently, there has also been an increase of other wireless transmitters (radio or television stations).

The objective of this review is to detail advances in the knowledge of biological mechanisms and effects from radiofrequencies and microwaves on animals, and some considerations are made on its possible relationship with deformations and the population decline of amphibians.

Main causes of populational decline and appearance of deformations in amphibian populations

Ultraviolet radiation

UV-B radiation (1) induces mutations and cellular death, (2) weakens the immune system, (3) reduces growth, and (4) induces several types of damage, like malformations of the limbs, body, and eyes [1,5,12,14]. Not all the species respond in the same way [14]. Embryos with higher photolyase levels (DNA photorepair enzyme) are more resistant to UV-B radiation [11,12].

The eggs of some of the amphibian species experienced high mortality that may contribute to the populational declines [9]. UV acts in conjunction with other agents like pesticides to induce defects in the development [10]. UV also decreases defense mechanisms against illnesses making individuals more susceptible to pathogen and parasites, affecting normal development and increasing mortality that consequently impacts on the decline of some populations [10]. The egg mass protected from UV-B radiation have significantly more hatching, less deformities, and develop more quickly [10].

Synergy between a pathogenic fungus and UV-B radiation increased mortality among amphibian embryos [12]. The synergy may occur when developing amphibians have reduced ability to respond to a stressor in the presence of another stressor. For example, contamination exerts more deleterious effects with UV-B [1]. Animals use molecular and physiologic mechanisms and certain behaviors [22] to limit their exposure to UV-B and repair from UV-B damage [14].

Although cellular repair mechanisms of several species are not effective in the presence of persistent increase in UV-B radiation levels [14], amphibians are relatively resistant to this radiation if they can repair the damage effectively [14]. In some species, photoreactivation is the most important repair mechanism of UV-damaged DNA [9]. Heat shock proteins may also play a role in protecting cells from UV-B damage, since they prevent the denaturation of proteins during exposure to environmental stress [14].

Chemical pollutants

Chemical pollutants appear in areas where pesticides and fertilizers are applied extensively and produce mortality and deformities in amphibians. Although on a broad scale, no correlation between pesticide contamination and amphibian deformities was found, pesticides cannot be completely ruled out as causal agents [5].

Pathogens and parasites

Three pathogens received attention recently for having produced an amphibian populational decline in some areas: *Batrachochytrium denderobatidis*, *Saprolegnia ferax*, and an iridovirus (*Ambystoma tigrinum virus*) [1]. The parasite *Ribeiroia ondatrae* is an important source of malformations of amphibian extremities in western USA [16]. Larvae with malformations experience higher mortality before and during metamorphosis than the normal ones. The relevance of infection by *Ribeiroia* and the influence of habitat alteration on the pathology and biological cycle of this trematode, requires further investigation [16]. In relative pristine environments, the incidence of snails infected with *Ribeiroia* is low, but the habitat alteration can increase the rate of infestation [16]. Infection of amphibian larvae by the trematode *R. ondatrae* may represent a threat to amphibians or species in decline. Although deformities can be the cause of declines in some places, numerous populations of amphibians have greatly declined in the absence of any deformity, for which there must be other factors [6].

Climatic change

Climatic change influences breeding patterns of certain organisms which affect their populational structure and may be reflected in the populational declines of very sensitive species such as amphibians. The pattern found up to now in the published studies is that some anurans of temperate areas show an early reproduction tendency [17]. Climate-induced reductions in water depth at egg-laying sites produced high embryo mortality by increasing their exposure to UV-B radiation which is more worrying than the reduction in ozone layer. Climate also increases their vulnerability to *S. ferax* [4].

Physical and technological characteristics of mobile telephone

Electromagnetic radiation (EMR) transmits small packages of energy denominated photons [23]. The radiofrequencies occupy the range from 10 MHz to 300 GHz. Cellsite antennae emit a frequency of 900 or 1800 MHz, pulsed at low frequencies, generally known as microwaves (300 MHz–300 GHz). Microwaves carry sound information by blasts or pulses of short duration, with small modulations of their frequency, that are transferred between wireless phones and base stations over dozens of kilometres.

The main variable that measures these radiations is 'power density' (measured in $W\,m^{-2}$, or $\mu W\,cm^{-2}$) expressing radiant power that impacts perpendicularly to a surface, divided by the surface area; and 'electric field intensity' (measured in $V\,m^{-1}$), a vectorial magnitude to the force exercised on a electric loaded particle, independent of their position in space.

For a concrete address with relationship to an antenna, the power density at a point varies inversely proportional to the square of the distance to the source. Though EMR have many and varied outputs, at a distance of 50 m the power density is about $10\,\mu W\,cm^{-2}$ [24], while at distances of 100 m at ground level it measures above $1\,\mu W\,cm^{-2}$ (pers. obs.). Between 150 and 200 m, the power density of the main lobe near the ground is typically some tenth of $1\,\mu W\,cm^{-2}$ [25].

Experimental difficulties

Experiments that study the effects of EMR on living organisms are complex, since a high number of variables exist that need to be controlled. Microwave radiation produces different effects depending on certain methodological positions such as frequency, power, modulation, pulses, time of exposure, etc. [26–28]. Some studies demonstrated different microwave effects depending on the wavelength in the range of mm, cm or m [28,29]. The dose–response relationships (of non-thermal effects), are not simple to establish since they present a non-linear relationship [30–32].

Pulsed waves (in blasts), as well as certain low frequency modulations exert greater biological activity [26,28,31,33]. These radiations also have accumulative effects that depend on the duration of exposure [19,34,35]. It is possible that each species and each individual, show different susceptibility to radiations, since the vulnerability depends on the genetic tendency, and the physiologic and the neurological state of the irradiated organism [31,36–41].

Effects and action mechanisms on biological systems

One of the well known effects of microwaves is their capacity to excite water molecules and other components in food, elevating their temperature. The resulting heating level depends on the radiation intensity and the exposure time. At a power density above $500\,\mu W\,cm^{-2}$

(microwave ovens) heating effects take place, below that level the effects are 'athermal non-heating'.

Animals are sensitive complex electrochemical systems that communicate with their environment through electrical impulses. In cellular membranes and body fluids, ionic currents and electrical potential exist [42]. Electromagnetic fields (EMFs) generated in biological structures, are characterized by certain specific frequencies. It is possible a frequency-specific, non-thermal electromagnetic influence, of an informational nature exists [25,31,43]. Some organs or systems like the brain, heart, and nervous system are especially vulnerable.

The wave systems have properties such as the frequency, which affect resonance capacity of living organisms to absorb the energy of an electromagnetic field [25]. Electromagnetic fields induce biological effects at "windows of frequency" (window effect) [44]. Living organisms are exposed to variable levels of radiofrequency electromagnetic fields, according to (1) distance to phone masts, (2) presence of metallic structures which are able to reflect or obstruct the waves (buildings or other obstacles), (3) number of phone masts, and (4) orientation and position [24].

Microwaves emitted by phone antennae affect organisms living in their vicinities, like vertebrate [45–47], insects [48–55], vegetables [56–58], and humans [25,31,59–63]. Small organisms are especially vulnerable: size approach to resonance frequency and thinner skull, facilitates an elevated penetration of radiation into the brain [24,31,64]. In a recent study carried out with bees in Germany, only few irradiated bees returned to the beehive and required more time to reach the hive. The weight of honeycombs is also smaller in the bees that were irradiated [54].

The microwave effects were investigated in a variety of living organisms, but the results found in vertebrates have special interest to amphibians. For more than 30 years, there is growing evidence on the existence of athermal effects on birds [65,66]. The exposed animals suffer a deterioration of health in the vicinity of phone masts [67,68]. Rats spent more time in the halves of shuttle boxes that were shielded from illumination by 1.2 GHz microwaves. The average power density was about $0.6\,\mathrm{mW\,cm^{-2}}$. Data revealed that rats avoided the pulsed energy, but not the continuous energy, and less than $0.4\,\mathrm{mW\,cm^{-2}}$ average power density was needed to produce aversion [69]. Navakatikian and Tomashevskaya [70] described a complex series of experiments in which they observed disruption of a rat behavior (active avoidance) by radiofrequency radiation (RFR). Behavioral disruption was observed at $0.1\,\mathrm{mW\,cm^{-2}}$ ($0.027\,\mathrm{W\,kg^{-1}}$) power density.

It has been documented that the radiofrequencies induce biological effects on biomolecules [27,51,71] that include changes in intracellular ionic concentration [72,73], cellular proliferation [74], interferences with immune system [19,75,76], effects on animals reproductive capacity [77,78], effects on stress hormones [79], in intrauterine development [80], genotoxic effects [81–87], effects on the nervous system [32,88–92], the circulatory system [93,94], and a decline in the number of births [47,95]. Firstenberg [18] proposed a connection between EMR, deformations, and the worldwide decline and extinction of amphibians.

Evidence that electromagnetic contamination may be responsible for the appearance of deformities and decline of amphibians

Some athermal effects of EMR on amphibians have been well known for more than 35 years [96,97]. The radiation of frogs with $30–60\,\mu\mathrm{W\,cm^{-2}}$ produced a change in the heart rhythm, probably due to the nervous system activation (Levitina, 1966 cited in [96]). When toad hearts were irradiated with pulses of 1425 MHz at a power density of $0.6\,\mu W\,cm^{-2}$, an increase in the heart rate and arrhythmia were observed [96]. Radiofrequency burst-type dilated arterioles were observed on the web of the anaesthetized frog (*Xenopus laevis*) by a athermal non-heating mechanism [93].

The exposure to magnetic fields on two species of amphibians induced deformities [48].

Frog tadpoles (*Rana temporaria*) developed under electromagnetic field (50 Hz, $260\,A\,m^{-1}$) have increased mortality. Experimental tadpoles developed more slowly and less synchronously than control tadpoles, remain at the early stages for a longer time. Tadpoles developed allergies and EMF causes changes in the blood counts [98].

Amphibians can be specially sensitive: thresholds of an overt avoidance response to weak electrical field stimuli down to $0.01\,V\,m^{-1}$ were found in *Proteus anguinus* and $0.2\,V\,m^{-1}$ in *Euproctus asper* at 20–30 Hz, but sensitivity covered a total frequency range of below 0.1 Hz to 1–2 kHz [99].

Deformities in nature

Ultraviolet radiation, UV-B. UV-B radiations produce deformities in amphibian embryos that go from lateral flexure of the tail to abnormal skin, eye damage, and lower survival rate [6,10]. However, numerous experiments carried out did not provide evidence that this exposure induces all types of deformities observed in nature, nor the appearance of extra limbs, one of the most frequent deformities noted [5,6]. On the other hand, most of the deformations for UV-B radiation occur in the legs or in reduction of the number of bilateral fingers. However, in the wild, amphibians exhibit a wide diversity of aberrations that are limited to only one side of the body, including problems in the skin, loss of legs, and twisted internal organs, reasons for which it was considered that this radiation is not the only source [5]. Similar abnormalities found in the wild and not induced by UV-B radiation have been obtained in laboratory studies, by exposing amphibian larvae to magnetic fields [48]. A similarity exists in the deformations of amphibians observed by Levengood [48] and Blaustein and Johnson [5]. Several studies addressed behavior and teratology in young birds exposed to electromagnetic fields [39,41]. Typical abnormalities include malformation of the neural tube and abnormal twisting of the chicken embryo. The electric currents are believed to have a significant role in the control of development and it is also possible that external EMR could influence these control systems [100]. The appearance of morphological abnormalities influenced by pulsed electromagnetic fields during embryogenesis in chickens [33,101] are similar to those produced by ultraviolet radiation [36]. The pulses are in fact a characteristic of mobile telephone radiations that have increased from 1995, when a marked rise in deformations started. Several experimental studies point out that the exposure to UV-B produced deferred effects (early exposure causes delayed effects in later stages) [1]. The exposure to electromagnetic fields also induces delayed effects and the tadpoles are the same as the control until the beginning of metamorphosis. The extra limbs and blistering were induced during the gastrula stage of the development which appeared to be the most sensitive stage [48]. The early *Rana pipiens* embryonic development was also inhibited by magnetic fields [97]. In rats, brief intermittent exposure to low-frequency EMFs during the critical prenatal period for neurobehavioral sex differentiation can demasculinize male scent marking behavior and increase accessory sex organ weights in adulthood [102]. Biological effects resulting from EMR field exposures might depend on the dose (e.g. duration of exposure). Short-term exposures up-regulate cell repair mechanisms, whereas long-term exposures appear to down-regulate protective responses to UV radiation [103].

Parasites. The parasite *R. ondatrae* is an important and extensive cause of malformations in amphibian extremities in western USA [16]. Tadpoles with malformations experience higher mortality than the normal ones before and during metamorphosis. The *Ribeiroia* infection represents a threat for amphibian populations that are in decline. However, with a growing volume of data based on the experimental evidence, the infection from parasites does not seem to be the cause of all the malformations on limbs, since in some places with the presence of deformations, the parasite *R. ondatrae* was absent [5]. Further certain deformities like the absence of eyes, limbs, and twisted internal organs was not induced by the parasite [5].

In a laboratory study, eggs and embryos of *Rana sylvatica* and *Ambystoma maculatum* were exposed to magnetic fields at several development stages. A brief treatment of the early embryo produced several types of abnormalities: microcephalia, scoliosis, edema, and retarded growth [48]. Several of the treated tadpoles developed severe leg malformations and extra legs, as well as a pronounced alteration of histogenesis which took the form of subepidermal blistering and edema [48]. In chick embryos exposed to pulsed EMR a potent teratogenic effect was observed: microphthalmia, abnormal trunkal torsion, and malformations on the neural tube [33,36,101,104]. One of the possible reasons for these deformities appearing more often [5], may be due to wireless telecommunications and exponential increase of electromagnetic contamination.

Bioelectric fields have long been suspected to play a causal role in embryonic development. The electrical field may directly affect the differentiation of some tail structures, in particular those derived from the tail bud. Alteration of the electrical field may disrupt the chemical gradient and signals received by embryo cells. It appears that in some manner, cells sense their position in an electrical field and respond appropriately. The disruption of this field alters their response. Endogenous current patterns are often correlated with a specific morphogenetic events such a limb bud formation. The most common defect in chick embryos experimental group was in tail development. Internally, tail structures (neural tube, notochord, and somites) were frequently absent or malformed. Defects in limb bud and head development were also found in experimentally treated chick embryos, but less often than the tail defects [105]. Amphibians can be especially sensitive because their skin is always moist, and they live close to, or in water, which conducts electricity easily.

Populations' decline

Deformities found in nature can directly affect embryonic mortality and survival after hatching [10]. It seems interactions that exist among UV-B radiation and additional factors contribute to embryo mortality [9]. Water pollution and excessive ultraviolet radiation act jointly, producing specific problems and alter the immune system, making amphibians more vulnerable to parasitic invasions and pathogen infections [6,8,12,14]. It is proposed that there exists a possible relationship between the decline of amphibians and exponential increase of electromagnetic pollution. Several experiments with bird eggs showed a high mortality of embryos exposed to EMR from mobile phones [36,106,107]. EMFs increases mortality of tadpoles [98]. The EMR alters the immune, nervous, and endocrine systems, and operates independent or together with other factors like UV-B radiation or chemical pollutants. Death of embryos in nature is not due to UV radiation as the capacity of DNA repair mechanisms like photolyase (photoreactivating enzyme) is effective [9]. EMR produces stress on the immune system [76,98] that obstructs DNA repair [42,108,109]. Heat shock proteins may play a role in protecting amphibians from UV-B damage [14] and animals exposed to EMR [27,51,71,110,111]. Different susceptibility to UV among species and even among populations exists [112], as seen with EMR [31,40].

Hallberg and Johansson [108,109] proposed that radiofrequencies increase the effects of UV radiation. A study on the causes of melanoma in humans conclude that the incidence increases and the mortality associated with this skin tumor cannot only be explained by the elevation in UV sun radiation, but rather by the continuous alterations on mechanisms of cellular repair, produced by EMR (radiofrequencies) resonant with the body, that amplify the carcinogenic effects of the cellular damage induced by the UV-B radiation. The cases of melanoma experienced a significant increase from the 1960–70s [108] that continues today, and also asthma and several types of cancer associated with deterioration of immune system. Data suggest there is an increase of electromagnetic pollution [108,113]. The public health situation in Sweden has become worse since the autumn of 1997. There is a correlation between the massive roll-out of GSM mobile phone antennae and adverse health effects [109].

Enigmatic decline of amphibian species are positively associated with streams at high elevations in the tropics and negatively associated with still water and low elevations [3]. In high places, the electromagnetic contamination is usually higher [47]. Microwave measurements of power density as low as $0.0006\,\mu W\,cm^{-2}$ show strong correlation with symptoms like depressive tendency, fatigue, and insomnia in humans [63].

Proposed research

To demonstrate the conclusive effect of microwave radiation on amphibians it is necessary to approach research with a control (non-exposed) and an experimental group. This methodological position is complicated at present due to the ubiquity of these radiations [98]. Studies that try to correlate populational evolution, appearance of deformities, or the presence or absence of amphibians with measurements of electromagnetic fields from radiofrequencies will be of great interest. Field investigations of urban park populations and phone masts surrounding territories need to be high-priority. A radius of $1\,km^2$ laid out in concentric circumferences at intermediate distances may be useful to investigate the differential results among areas, depending on their vicinity and corresponding levels of EMR. Laboratory studies on amphibians exposed to pulsated and modulated microwaves would also be of great interest.

Acknowledgments

The author is grateful to Denise Ward who revised the English version of this article and thanks Sam Kacew and Miguel Lizana for the valuable suggestions to a first manuscript of this article. The author would like to thank "Centro de Información y Documentación Ambiental" in Castilla y León (Spain) and Roberto Carbonell for providing some articles.

References

1. Blaustein AR, Kiesecker JM. Complexity in conservation: Lessons from the global decline of amphibian populations. Ecol. Lett. 2002;5:597–608.
2. IUCN. Global amphibian assessment. Washington, DC: Center for Applied Biodiversity Science; 2004.
3. Stuart SN, Chanson JS, Cox NA, Young BE, Rodrigues AS, Fischman DL, Waller RW. Status and trends of amphibian declines and extinctions worldwide. Science 2004;306:1783–1786.
4. Kiesecker JM, Blaustein AR, Belden LK. Complex causes of amphibian population declines. Nature 2001;410:681–684.
5. Blaustein AR, Johnson PTJ. The complexity of deformed amphibians. Front. Ecol. 2003;1:87–94.
6. Blaustein AR, Johnson PTJ. Explaining frog deformities. Sci. Am. 2003;288:60–65.
7. Kiesecker JM. Synergism between trematode infection and pesticide exposure: A link to amphibian limb deformities in nature? Proc. Nat. Acad. Sci. USA 2002;99:9900–9904.
8. Blaustein AR, Romansic JM, Kiesecker JM, Hatch AC. Ultraviolet radiation, toxic chemicals and amphibian population declines. Diversity Distribut. 2003;9:123–140.
9. Blaustein AR, Hoffman PD, Kiesecker JM, Hays JB. DNA repair activity and resistance to solar UV-B radiation in eggs of the red-legged frog. Conserv. Biol. 1996;10:1398–1402.
10. Blaustein AR, Kiesecker JM, Chivers DP, Anthony RG. Ambient UV-B radiation causes deformities in amphibian embryos. Proc. Nat. Acad. Sci. 1997;94:13735–13737.
11. Blaustein AR, Hays JB, Hoffman PD, Chivers DP, Kiesecker JM, Leonard WP, Marco A, Olson DH, Reaser JK, Anthony RG. DNA repair and resistance to UV-B radiation in western spotted frogs. Ecol. Applicat. 1999;9:1100–1105.
12. Middleton EM, Herman JR, Celarier EA, Wilkinson JW, Carey C, Rusin RJ. Evaluating ultraviolet radiation exposure with satellite data at sites of amphibian declines in Central and South America. Conserv. Biol. 2001;15:914–929.
13. Ankley GT, Diamond SA, Tietge JE, Holcombe GW, Jensen KM, DeFoe DL, Peterson R. Assessment of risk of solar ultraviolet radiation to amphibians. I. Dose-dependent induction of hindlimb malformations in the Northern Leopard Frog (*Rana pipiens*). Environ. Sci. Technol. 2002;36:2853–2858.
14. Blaustein AR, Belden LK. Amphibian defenses against ultraviolet-B radiation. Evolut. Dev. 2003;5:89–97.
15. Battaglin W, Fairchild J. Potential toxicity of pesticides measured in midwestern streams to aquatic organisms. Water Sci. Technol. 2002;45:95–102.
16. Johnson PTJ, Lunde KB, Thurman EM, Ritchie EG, Wray SN, Sutherland DR, Kapfer JM, Frest TJ, Bowerman J, Blaustein AR. Parasite (*Ribeiroia ondatrae*) infection linked to amphibian malformations in the Western United States. Ecol. Monogr. 2002;72:151–168.
17. Blaustein AR, Belden LK, Olson DH, Green DM, Root TL, Kiesecker JM. Amphibian breeding and climate change. Conserv. Biol. 2001;15:1804–1809.
18. Firstenberg A. Microwaving our planet: The environmental impact of the wireless revolution. Brooklyn, NY 11210: Cellular Phone Taskforce; 1997.
19. Galeev AL. The effects of microwave radiation from mobile telephones on humans and animals. Neurosci. Behav. Physiol. 2000;30:187–194.
20. Cooper M, Goldburg M. Intelligent antennas: Spatial division multiple access. Annu. Rev. Communicat. 1996;1:999–1002.
21. Cooper M. Antenas adaptables. Investigación y Ciencia 2003;324:41–47.
22. Marco A, Lizana M, Alvarez A, Blaustein AR. Egg-wrapping behaviour protects new embryos from UV radiation. Animal Behav. 2001;61:1–6.
23. Aguilar M. Bioelectromagnetismo: Campos eléctricos y magnéticos y seres vivos. Consejo Superior de Investigaciones Científicas; 2001.
24. Santini R, Seigne M, Bonhomme-Faibre L. Danger des téléphones cellulaires et de leurs stations relais. Pathol. Biol. 2000;48:525–528.
25. Hyland GJ. Physics and biology of mobile telephony. Lancet 2000;356:1–8.
26. Grigor'ev IUG. Role of modulation in biological effects of electromagnetic radiation. Radiat. Biol. Radioecol. 1996;36:659–670.
27. Daniells C, Duce I, Thomas D, Sewell P, Tattersall J, de Pomerai D. Transgenic nematodes as biomonitors of microwave-induced stress. Mutat. Res. 1998;399:55–64.
28. Nikolaevich N, Igorevna A, Vasil G. Influence of high-frequency electromagnetic radiation at non-thermal intensities on the human body (A review of work by Russian and Ukrainian researchers). No Place to Hide, 3. Supplement; 2001.

29. Kemerov S, Marinkev M, Getova D. Effects of low-intensity electromagnetic fields on behavioral activity of rats. Folia Med. 1999;41:75–80.
30. Monteagudo JL. Bioelectromagenetismo y salud pública efectos, prevención y tratamiento. En. J.L. Bardasano. IBASC Alcala de Henares 1997;201–210.
31. Hyland GJ. The physiological and environmental effects of non-ionising electromagnetic radiation. Working document for the STOA Panel. European Parliament. Directorate General for Research; 2001.
32. Marino AA, Nilsen E, Frilot C. Nonlinear changes in brain electrical activity due to cell phone radiation. Bioelectromagnetics 2003;24:339–346.
33. Úbeda A. Trillo MA, Chacón L, Blanco MJ, Leal J. Chick embryo development can be irreversibly altered by early exposure to weak extremely-low-frequency magnetic fields. Bioelectromagnetics 1994;15:385–398.
34. Adey WR. Bioeffects of mobile communications fields: Possible mechanisms for cumulative dose. In: Kuster N, Balzano Q, Lin JC, editors. Mobile Communication Safety. London: Chapman and Hall; 1996. pp 95–131.
35. Granlund-Lind R, Lind J. Black on white. Voices and witnesses about electro-hypersensitivity. The Swedish experience. Sweden: Mimers Brunn; 2004.
36. Farrel JM, Litovitz TL, Penafiel M. The effect of pulsed and sinusoidal magnetic fields on the morphology of developing chick embryos. Bioelectromagnetics 1997;18:431–438.
37. Mevissen M, Haübler M, Lerchl A, Loscher W. Acceleration of mammary tumorigenesis by exposure of 7,12-dimethylbenz(a)anthracene-treated female rats in a 50-Hz, 100-μT magnetic field: Replication study. J. Toxicol. Environ. Health, Part A 1998;53:401–418.
38. Flipo D, Fournier M, Benquet C, Roux P, Le Boulaire C, Pinsky C, LaBella FS, Krzystniak K. Increased apoptosis, changes in intracellular Ca^{2+}, and functional alterations in lymphocytes and macrophages after *in vitro* exposure to static magnetic field. J. Toxicol. Environ. Health, Part A 1998;54:63–76.
39. Fernie KJ, Leonard NJ, Bird DM. Behavior of free-ranging and captive American kestrels under electromagnetic fields. J. Toxicol. Environ. Health, Part A 2000;59:597–603.
40. Fedrowitz M, Kamino K, Löscher W. Significant differences in the effects of magnetic field exposure on 7,12 dimethylbenz(a)anthracene-induced mammary carcinogenesis in two sub-strains of Sprague-Dawley rats. Cancer Res. 2004;64:243–251.
41. Fernie KJ, Reynolds SJ. The effects of electromagnetic fields from power lines on avian reproductive biology and physiology: A review. J. Toxicol. Environ. Health, Part B 2005;8:127–140. (http://www.ierp.bham.ac.uk/publications/Fernie%20and%20Reynolds%202005.pdf).
42. Heredia-Rojas L, Rodriguez-Flores M, Santoyo-Stephano E, Castañeda-Garza A, Rodriguez-De la Fuente. Los campos electromagnéticos: ¿Un problema de salud pública? Respyn. 2003;4:1–10.
43. Smith CW, Bese S. Electromagnetic man. London: Dent and Sons; 1989.
44. Adey WR. Tissue interactions with non-ionizing electromagnetic fields. Physiol. Rev. 1981;61:435–514.
45. Balmori A. Aves y telefonía móvil. Resultados preliminares de los efectos de las ondas electromagnéticas sobre la fauna urbana. El ecologista 2003;36:40–42.
46. Balmori A. Posibles efectos de las ondas electromagnéticas utilizadas en la telefonía inalámbrica sobre los seres vivos. Ardeola 2004;51:477–490.
47. Balmori A. Possible effects of electromagnetic fields from phone masts on a population of white stork (*Ciconia ciconia*). Electromagnetic Biol. Med. 2005;24:109–119.
48. Levengood WC. A new teratogenic agent applied to amphibian embryos. J. Embryol. Exp. Morphol. 1969;21:23–31.
49. Carpenter RL, Livstone EM. Evidence for nonthermal effects of microwave radiation: Abnormal development of irradiated insect pupae. IEEE Trans Microwave Theory Tech. 1971;19:173–178.
50. Ramírez E, Monteagudo JL, Garcia-Gracia M, Delgado JM. Oviposition and development of Drosophila modified by magnetic fields. Bioelectromagnetics 1983;4:315–326.
51. Weisbrot D, Lin H, Ye L, Blank M, Goodman R. Effects of mobile phone radiation on reproduction and development in *Drosophila melanogaster*. J. Cell. Biochem. 2003;89:48–55.
52. Pan H, Liu X. Apparent biological effect of strong magnetic field on mosquito egg hatching. Bioelectromagnetics 2004;25:84–91.
53. Panagopoulos DJ, Karabarbounis A, Margaritis LH. Effect of GSM 900 MHz mobile phone radiation on the reproductive capacity of *Drosophila melanogaster*. Electromagnetic Biol. Med. 2004;23:29–43.
54. Stever H, Kuhn J, Otten C, Wunder B, Harst W. Verhaltensanderung unter elektromagnetischer Exposition. Pilotstudie. Institut für mathematik. Arbeitsgruppe. Bildungsinformatik. Universität Koblenz-Landau; 2005. http://agbi.uni-landau.de/.

55. Balmori A. Efectos de las radiaciones electromagnéticas de la telefonía móvil sobre los insectos. Ecosistemas./1; 2006. (URL: http://www.revistaecosistemas.net/articulo.asp?Id=396&Id_Categoria=2&tipo=portada).
56. Selga T, Y Selga M. Response of *Pinus Sylvestris* L. needles to electromagnetic fields. Cytological and ultrastructural aspects. Sci. Total Environ. 1996;180:65–73.
57. Balodis VG, Brumelis K, Kalviskis O, Nikodemus D, Y Tjarve VZ. Does the Skrunda radio location station diminish the radial growth of pine trees? Sci. Total Environ. 1996;180:57–64.
58. Balmori A. Pueden afectar las microondas pulsadas emitidas por las antenas de telefonía a los árboles y otros vegetales?. Ecosistemas 2004;3:1–10. (http://www.revistaecosistemas.net/articulo.asp?Id=29&Id_Categoria=1&tipo=otros_contenidos).
59. Santini R, Santini P, Danze JM, Le Ruz P, Seigne M. Enquête sur la santé de riverains de stations relais: I. Incidences de la distance et du sexe. Pathol. Biol. 2002;50:369–373.
60. Santini R, Santini P, Le Ruz P, Danze JM, Seigne M. Survey study of people living in the vicinity of cellular phone base stations. Electromagnetic Biol. Med. 2003a;22:41–49.
61. Santini R, Santini P, Danze JM, Le Ruz P, Seigne M. Symptoms experienced by people in vicinity of base stations: II/Incidences of age, duration of exposure, location of subjects in relation to the antennas and other electromagnetic factors. Pathol. Biol. 2003b;51:412–415.
62. Navarro EA, Segura J, Portolés M, Gómez Perretta C. The microwave syndrome: A preliminary study in Spain. Electromagnetic Biol. Med. 2003;22:161–169.
63. Oberfeld G, Navarro E, Portoles M, Maestu C, Gomez-Perretta C. The microwave syndrome – further aspects of a Spanish study. EBEA Congres Kos-Greece 2004;1:1–9.
64. Maisch D. Children and mobile phones… Is there a health risk? The case for extra precautions. J. Australian Coll. Nutr. Environ. Med. 2003;22:3–8.
65. Tanner JA. Effect of microwave radiation on birds. Nature 1966;210:636.
66. Tanner JA, Romero-Sierra C, Davie SJ. Non-thermal effects of microwave radiation on birds. Nature 1967;216:1139.
67. Marks TA, Ratke CC, English WO. Strain voltage and developmental, reproductive and other toxicology problems in dogs, cats and cows: A discussion. Vet. Human Toxicol. 1995;37:163–172.
68. Löscher W, Käs G. Conspicuous behavioural abnormalities in a dairy cow herd near a TV and radio transmitting antenna. Practical Vet. Surgeon 1998;29:437–444.
69. Frey AH, Feld SR. Avoidance by rats of illumination with low power non-ionizing electromagnetic energy. J. Comp. Physiol. Psychol. 1975;89:183–188.
70. Navakatikian MA, Tomashevskaya LA. Phasic behavioral and endocrine effects of microwaves of nonthermal intensity. In: Carpenter DO, editor. Biological effects of electric and magnetic fields. Vol. 1. San Diego, CA: Academic Press; 1994.
71. De Pomerai D, Daniells C, David H, Allan J, Duce I, Mutwakil M, Thomas D, Sewell P, Tattersall J, Jones D, Candido P. Non-thermal heat-shock response to microwaves. Nature 2000;405:417–418.
72. Dutta SK, Ghosh B, Blackman CF. Radiofrequency radiation-induced calcium ion efflux enhancement from human and other neuroblastoma cells in culture. Bioelectromagnetics 1989;10:197–202.
73. Paulraj R, Behari J, Rao AR. Effect of amplitude modulated RF radiation on calcium ion efflux and ODC activity in chronically exposed rat brain. Indian J. Biochem. Biophys. 1999;36:337–340.
74. Velizarov S, Raskmark P, Kwee S. The effects of radiofrequency fields on cell proliferation are non-thermal. Bioelectrochem. Bioenerg. 1999;48:177–180.
75. Chou CK, Guy AW, Kunz LL, Johnson RB, Crowley JJ, Krupp JH. Long-term, low-level microwave irradiation of rats. Bioelectromagnetics 1992;13:469–496.
76. Novoselova ET, Fesenko EE. Stimulation of production of tumor necrosis factor by murine macrophages when exposed *in vivo* and *in vitro* to weak electromagnetic waves in the centimeter range. Biofizika 1998;43:1132–1133.
77. Dasdag S, Ketani MA, Akdag Z, Ersay AR, Sar I, Demirtas ÖC, Celik MS. Whole body microwave exposure emitted by cellular phones and testicular function of rats. Urol. Res. 1999;27:219–223.
78. Davoudi M, Brössner C, Kuber W. Der Einfluss elektromagnetischer wellen auf die Spermienmotilität. J. Urol. Urogynäkol. 2002;9:18–22.
79. Vangelova KK, Israel MS. Variations of melatonin and stress hormones under extended shifts and radiofrequency electromagnetic radiation. Rev. Environ. Health 2005;20:151–61.
80. Tofani S, Agnesod G, Ossola P, Ferrini S, Bussi R. Effects of continuous low-level exposure to radio-frequency radiation on intrauterine development in rats. Health Physics 1986;51:489–499.

81. Garaj-Vrhovac V, Horvat D, Koren Z. The relationship between colony-forming ability, chromosome aberrations and incidence of micronuclei in V79 Chinese hamster cells exposed to microwave radiation. Mutat. Res. 1991;263:143–149.
82. Lai H, Singh NP. Acute low-intensity microwave exposure increases DNA single-strand breaks in rat brain cells. Bioelectromagnetics 1995;16:207–210.
83. Balode S. Assessment of radio-frequency electromagnetic radiation by the micronucleus test in bovine peripheral erythrocytes. Sci. Total. Environ. 1996;180:81–85.
84. Belyaev I, Hillert L, Markova E, Sarimov R, Malmgren L, Persson B, Harms-Ringdahl M. Microwaves of mobile phones affect human lymphocytes from normal and hypersensitive subjects dependent on frequency. presented at 26th Annual Meeting of the Bioelectromagnetics (BEMS), Washington, USA; 2004.
85. Demsia G, Vlastos D, Matthopoulos DP. Effect of 910-MHz electromagnetic field on rat bone marrow. Sci. World J. 2004;4:48–54.
86. Reflex. 2004. http://www.verum-foundation.de/cgi-bin/content.cgi?id=euprojekte01.
87. Diem E, Schwarz C, Adlkofer F, Jahn O, Rudiger H. Non-thermal DNA breakage by mobile-phone radiation (1800 MHz) in human fibroblasts and in transformed GFSH-R17 rat granulosa cells *in vitro*. Mutat. Res. 2005;583:178–183.
88. Kolodynski AA, Kolodynska VV. Motor and psychological functions of school children living in the area of the Skrunda Radio Location Station in Latvia. Sci. Total Environ. 1996;180:87–93.
89. Beasond RC, Semm P. Responses of neurons to an amplitude modulated microwave stimulus. Neurosci. Lett. 2002;33:175–178.
90. Kramarenko AV, Tan U. Effects of high-frequency electromagnetic fields on human EEG: A brain mapping study. Int. J. Neurosci. 2003;113:1007–1019.
91. Salford LG, Brun AE, Eberhardt JL, Malmgren L, Persson BR. Nerve cell damage in mammalian brain after exposure to microwaves from GSM mobile phones. Environ. Health Perspect. 2003;111:881–893.
92. Adey WR. Electromagnetic fields, the modulation of brain tissue functions – A possible paradigm shift in biology. In: Smith B, Adelman G, editors. International Encyclopaedia of Neuroscience. New York: Elsevier; 2003. pp 1–21.
93. Miura M, Okada J. Non-thermal vasodilatation by radio frequency burst-type electromagnetic field radiation in the frog. J. Physiol. 1991;435:257–273.
94. Szmigielski S, Bortkiewicz A, Gadzicka E, Zmyslony M, Kubacki R. Alteration of diurnal rhythms of blood pressure and heart rate to workers exposed to radiofrequency electromagnetic fields. Blood Press. Monit. 1998;3:323–330.
95. Magras IN, Xenos TD. Radiation-induced changes in the prenatal development of mice. Bioelectromagnetics 1997;18:455–461.
96. Frey AH, Seifert E. Pulse modulated UHF energy illumination of the heart associated with change in heart rate. Life Sci. 1968;7:505–512.
97. Neurath PW. High gradient magnetic fields inhibit embryonic development of frogs. Nature 1968;21:1358–1359.
98. Grefner NM, Yakovleva TL, Boreysha IK. Effects of electromagnetic radiation on tadpole development in the common frog (*Rana temporaria* L.). Russ. J. Ecol. 1998;29:133–134.
99. Schlegel PA. Behavioral sensitivity of the European blind cave salamander, *Proteus anguinus*, and a pyrenean newt, *Euproctus asper*, to electrical fields in water. Brain Behav. Evol. 1997;49:121–131.
100. Juutilainen J, Harri M, Saali K, Lahtinen T. Effects of 100-Hz magnetic fields with various waveforms on the development of chick embryos. Radiat. Environ. Biophys. 1986;25:65–74.
101. Úbeda A, Leal J, Trillo MA, Jimenez MA, Delgado JMR. Pulse shape of magnetic fields influences chick embryogenesis. J. Anat. 1983;137:513–536.
102. McGivern RF, Sokol RZ, Adey WR. Prenatal exposure to a low-frequency electromagnetic field demasculinizes adult scent marking behavior and increases accessory sex organ weights in rats. Teratology 1990;41:1–8.
103. Di Carlo AL, Hargis MT, Penafiel LM, Litovitz TA. Short-term magnetic field exposures (60 Hz) induce protection against ultraviolet radiation damage. Int. J. Radiat. Biol. 1999;75:1541–1549.
104. Lahijani MS, Ghafoori M. Teratogenic effects of sinusoidal extremely low frequency electromagnetic fields on morphology of 24 hr chick embryos. Indian J. Exp. Biol. 2000;38:692–699.
105. Hotary KB, Robinson KR. Evidence of a role for endogenous electrical fields in chick embryo development. Development 1992;114:985–996.
106. Youbicier-Simo BJ, Lebecq JC, Bastide M. Mortality of chicken embryos exposed to EMFs from mobile phones. Presented at the Twentieth Annual Meeting of the Bioelectromagnetics Society, St. Pete Beach, FL, June 1998.

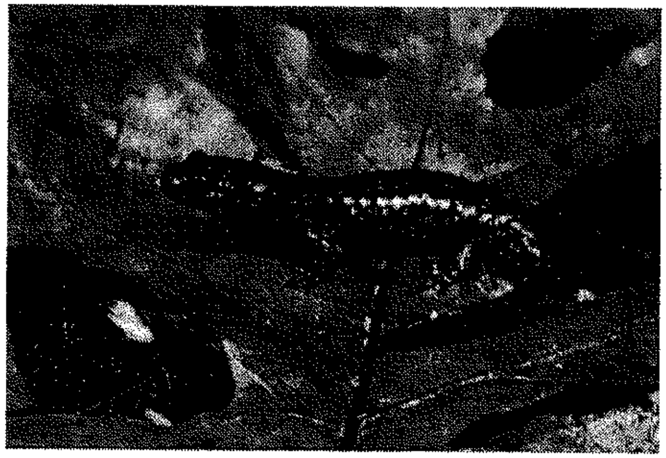
107. Grigoriev IUG. Influence of the electromagnetic field of the mobile phones on chickens embryo, to the evaluation of the dangerousness after the criterion of this mortality. J. Radiat. Biol. 2003;5:541–544.
108. Hallberg O, Johansson O. Malignant melanoma of the skin – not a sunshine story!. Med. Sci. Monit. 2004;10:336–340.
109. Hallberg Ö, Johansson O. Mobile handset output power and health. Electromagnetic Biol. Med. 2004;23:229–239.
110. Goodman R, Blank M. Insights into electromagnetic interaction mechanisms. J. Cell. Physiol. 2002;192:16–22.
111. Leszczynski D, Joenväärä S, Reivinen J, Kuokka R. Non-thermal activation of the hsp27/p38MAPK stress pathway by mobile phone radiation in human endothelial cells: Molecular mechanism for cancer- and blood–brain barrier-related effects. Differentiation 2002;70:120–129.
112. Belden LK, Blaustein AR. Population differences in sensitivity to UV-B radiation for larval long-toed salamanders. Ecology 2002;83:1586–1590.
113. Hallberg O, Johansson O. Cancer trends during the 20th century. J. Australian Coll. Nutr. Environ. Med. 2002;21:3–8.

Blumberg No. 5136
EXHIBIT
IJ27

Blue-spotted Salamander, *Ambystoma laterale* And Tremblay's salamander, *A. (2) laterale-jeffersonianum*

Status: (NJ) ***State:*** Endangered ***Federal:*** Not listed

Identification



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The blue-spotted salamander is a member of a group of subterranean amphibians known as "mole salamanders." Likened to the coloration and pattern of old-time enameled pots and pans, blue-spotted salamanders are dark blue with light blue flecking on the sides and tail. These salamanders have large heads with protruding eyes and robust, stocky bodies supported by sturdy limbs. Adults measure 10 to 14 cm (4 to 5.5 in.) in length (Conant and Collins 1991).

Habitat

Blue-spotted salamanders inhabit mature hardwood forests such as red maple (Acer rubrum) swamps and oak/birch woodlands. These forests, which provide ponds suitable for breeding, are often slightly above swamp or marshland levels. They contain a deep humus layer with sandy and silt loams, gravelly, loamy sand, or muck soil types. Tree species may include pin oak (Quercus palustris), black oak (Q. velutina), northern red oak (Q. rubra), red maple, black willow (Salix nigra), and gray birch (Betula populifolia). Typically, the ground is littered with rotting logs, boards, rocks, or leaves, beneath which the salamanders dwell within moist depressions or subterranean burrows.

Temporary woodland ponds, marshy sedge ponds, and roadside ditches may serve as breeding pools. Ephemeral breeding ponds typically have a muddy substrate (bottom) and contain leaf litter and fallen twigs with limited wetland vegetation. Marshy breeding ponds consist of dense submergent (underwater) vegetation and tussocks of emergent vegetation. The water must be deep enough to prevent the ponds from drying up before the juveniles emerge from the water, yet be shallow enough to avoid inhabitation by predatory fish. One breeding pond located in Morris County measured 35 m (115 ft.) long by 27 m (89 ft.) wide and was 98 cm (39 in.) deep at the lowest point (Zappalorti 1983). Other occupied ponds in this county contained water at depths of 15 to 25 cm (6 to 10 in.) (Nyman et al. 1988).

Status and Conservation

Due to its restricted range within the state and the severe threats of habitat loss and pesticide use, the blue-spotted salamander was listed as an endangered species in New Jersey in 1974. The New Jersey Natural Heritage Program considers the blue-spotted salamander to be "demonstrably secure globally," yet "critically imperiled in New Jersey" (Office of Natural Lands Management 1992).

At the end of the last ice age the ranges of the blue-spotted and another species of mole salamander, the Jefferson salamander, overlapped, which produced a series of hybrids that share many of the physical characteristics of the two parent species. One of the hybrids was found to be an all-female species that required male blue-spotted salamanders to reproduce. This hybrid was known as 'Tremblay's salamander.' Because of its close association and supposed reliance upon blue-spotted salamanders for reproduction, Tremblay's salamander was once listed as an endangered species in New Jersey. However, recent investigation into the genetics of the hybrids demonstrated that the Tremblay's salamander was not a true species but instead part of a dynamic hybrid complex that is still in taxonomic debate (Klemens and Bogart 1997).

Blumberg No. 5136
EXHIBIT
IJ28

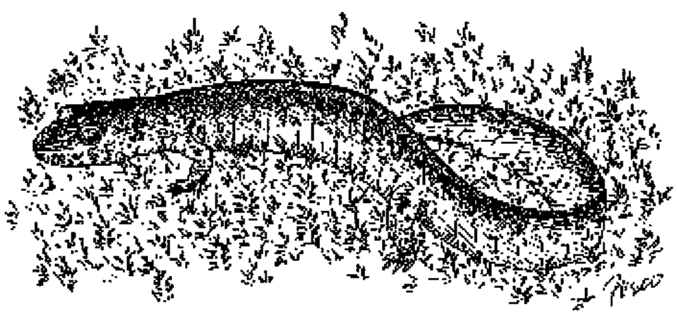
WILDLIFE IN CONNECTICUT

ENDANGERED AND THREATENED SPECIES SERIES

NORTHERN SPRING SALAMANDER

Gyrinophilus porphyriticus

THREATENED



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THREATENED

Habitat: Cool and well-shaded mountain springs at high elevations, and wet depressions beneath logs, stones, or leaves in surrounding forests.
Weight: Unknown.
Length: Adults, 5.5-7.5 inches; females are usually smaller than males.

Life Expectancy: Unknown, but greater than five years.
Food: Insects, crustaceans, centipedes, millipedes, earthworms, snails, spiders, and occasionally small frogs and salamanders.
Status: State threatened.

Identification: The spring salamander is one of the larger salamanders, with a stout body and a broad nose that ends abruptly. Its back and tail are light brownish-orange or salmon-red with small dark spots or flecks. A light line, bordered below by a dark line, begins at the eye and extends to the nostril. The belly is flesh-colored and the throat may be flecked with black. The tail has a prominent, knife-like keel on the top, which enables this salamander to swim in swift-moving water.

Range: The spring salamander is found from southwest Maine and southern Quebec to northern Alabama.

Reproduction: Unlike many of Connecticut's other large salamanders, which breed in the spring, the spring salamander breeds from mid-October through the winter months. During courtship, the male and female push each other and roll around in the water. The male deposits sperm, which is picked up and stored by the female until the eggs are laid from April through the summer. Between 9 and 144 eggs (average 40-60) are laid in running water under logs and stones, usually in groups or sometimes attached singly. The female guards the eggs, which hatch in late summer or early fall. The larval salamanders may remain near the nest site for several months after hatching and appear ghostly white with a purplish cast for up to 3 years. Females do not breed until they are about 5 years old.

Reason for Decline: Intensive development pressure throughout this salamander's range has caused disruption of many natural cold water springs. The loss of woodlands surrounding these springs has allowed water temperatures to rise, making the springs unsuitable for these salamanders. Pollution, degradation, and siltation of streams have also contributed to the decline in the spring salamander population.

History in Connecticut: Small populations of spring salamanders are scattered throughout the state. Long-established ıreeding populations are documented as declining and are considered likely to disappear unless special action is taken.

Interesting Facts: Spring salamanders are primarily nocturnal. They forage for food around rocks and vegetation in or long stream beds, and have been known to eat their own larvae.

The salamander spends the winter months in wet soil close to a source of water, where it remains somewhat active in ıurrows.

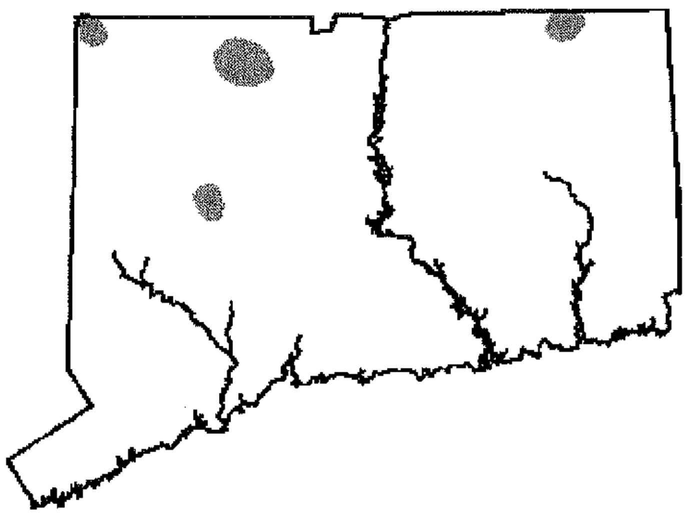
The purple color of young spring salamanders led to its former name, the purple salamander.

'rotective Legislation: *State* - Connecticut General Statutes Sec. 26-311.

Vhat You Can Do: Protection of cold forest streams and springs is essential to maintaining spring salamander habitats. 'rojects that help restore shade trees and shrubs along stream banks will help water temperatures remain suitable for this salamander.

Spring salamanders may not be collected from the wild. They do not make good pets and keeping them in captivity is illegal. Preventing illegal collection of these salamanders will help protect native populations.

Connecticut Range



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(rev. 12/99)

Housatonic State Forest

EXHIBIT
JJ29
Blumberg No. 5136

Map 5 of 8

Location: Canaan, Cornwall; South Canaan Quadrangle

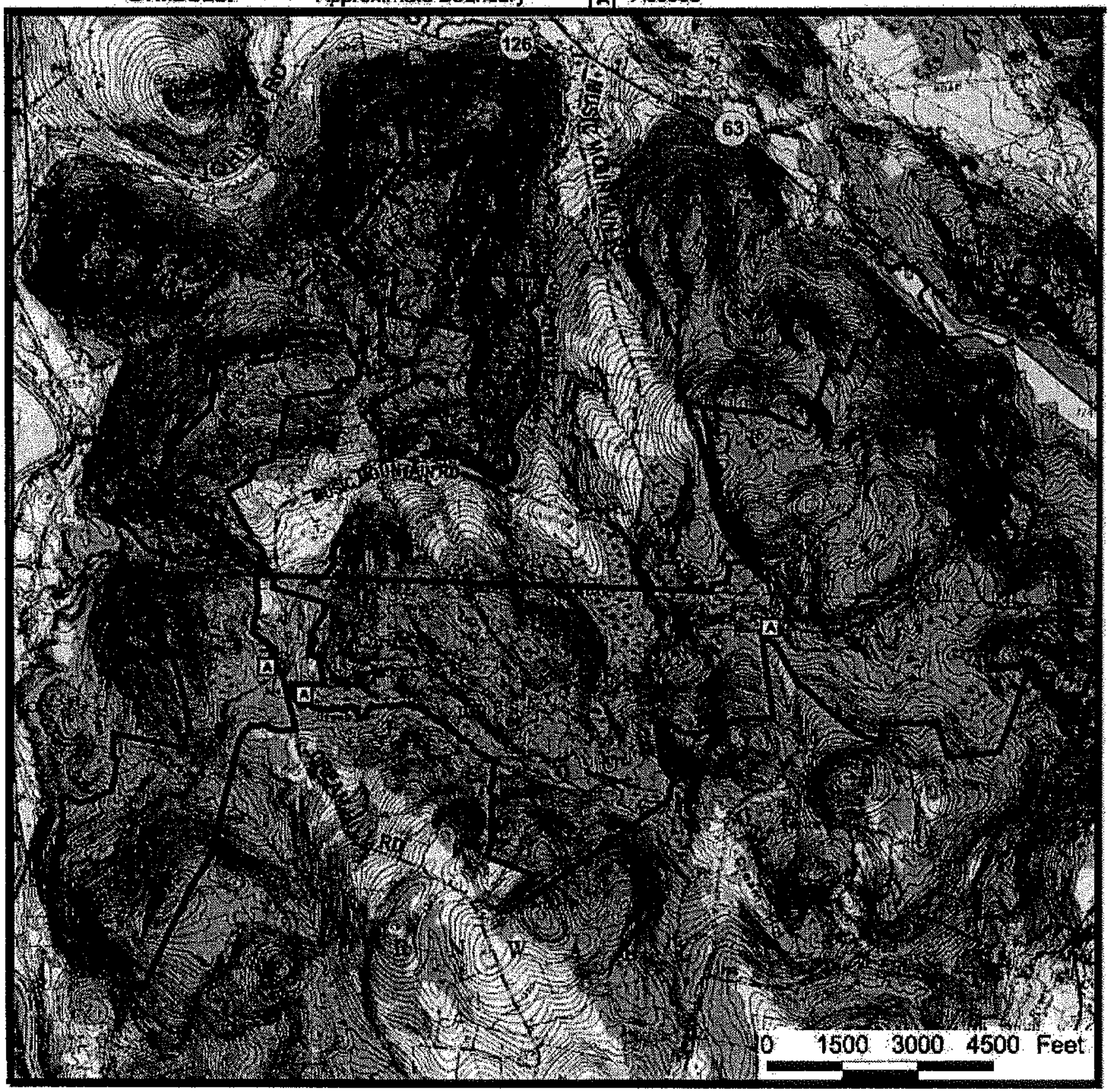
Description:

Access: From Route 63 on Music Mountain Rd. or Cream Hill Rd. from Route 128.

Map Updated: 3/1/01

Note: This map depicts an approximation of property boundaries. Please obey all postings.

SYMBOLS: — Approximate Boundary [A] Access



E LASER FROM SKOVRON

EXHIBIT IJ30

University of Connecticut
Department of Ecology and Evolutionary Biology

College of Liberal Arts
and Sciences

January 5, 2006

Open Space Acquisition Program
Department of Environmental Protection
79 Elm Street
Hartford, CT 06106-5127

Open Space Acquisition Program:

We are writing to draw your attention to what we believe is the most significant ecological community in the State of Connecticut and arguably one of the most important conservation targets in the Northeast: the limestone ridge system (often referred to as Point of Rocks) west of Sand Road in the towns of Falls Village and Canaan.

We are both professors in the Ecology and Evolutionary Department at the University of Connecticut, Co-directors of the University's Center for Conservation and Biodiversity, and serve on the Board of the Connecticut Chapter of the Nature Conservancy. DLW also serves (chairs) on the Connecticut's Advisory Committee for Rare Invertebrate Species.

Five state-listed species invertebrates occur at the Point of Rocks-Sand Road site—see Table 1. Both the endangered butterflies on the site, the Columbine Duskywing (*Erynnis lucillius*) and Northern Metalmark (*Calephalis borealis*) are regionally rare and declining. The largest populations of these two butterflies in the Northeast occur about the limestone quarries along Sand Road. The Northern Metalmark is a G3 (NatureServe 2005), and thus of global conservation concern. If we knew the ground fauna well--snails, ground beetles, ground-nesting bees--many other conservation targets would be found. The Columbine Stalk Borer (*Papaipema leucostigma*) was thought to be extirpated in the state until recently, when a specimen was found in a box of moths at the University of Connecticut collected at the Red Wing quarry in 2002.

Table 1. Rare insects known from Point of Rocks.

Common Name	Scientific Name	State Status	Hostplant
Columbine Duskywing Butterfly	*Erynnis lucillius*	Endangered	columbine
Northern Metalmark	*Calephelis borealis*	Endangered	roundleaf groundsel
Columbine Stalk Borer	*Papaipema leucostigma*	Special Concern (historic)(recently rediscovered)	columbine
Tawny Emporer	*Asterocampa clyton*	Special Concern	hackberry
Hackberry Butterfly	*Asterocampa celtis*	Special Concern	hackberry

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Town of Canaan
Planning and Zoning Commission
Regular Meeting
Wednesday, May 24, 2006, 7:00 P.M.
Town Hall, 108 Main Street, Falls Village, CT

Present: Chairman Fred Laser, Gregory Bidou, Jody Bronson, Alison Orr-Andrawes, Ruth Skovron, and Richard Stone. Alternates Stephen Koshland and Dan Shaw
Absent: Tom Scott and Alternate Vincent Inconiglios

A quorum was present and Chairman Laser called the Regular Meeting to order at 7:05 p.m.

Secretary's Report:
J. Bronson moved to approve the Minutes of the April 26, 2006 Regular Meeting as presented. R. Skovron seconded. Passed unanimously.

ZEO Report:
Zoning Enforcement Officer Michael O'Neil distributed his written report of activity (attached). Discussion about a subdivision application received from Edward Calandro will be addressed under Other Business.

Correspondence/Public Comment:
a. R. Skovron and J. Bronson reported positively on the Woodland Management Seminar from April 29th, co-sponsored by Town of Canaan P&Z. There were 52 attendees.

b. Skovron distributed a January 5, 2006 report (attached) from the Co-Directors of the UCONN Center for Conservation and Biodiversity. Presented to members of the Inland Wetlands Commission and other interested residents on May 1st, the report concerns the significance of a unique ecological community of plants and insects occurring at the limestone ridge system at Point-of-Rocks/Sand Road, including the quarries and other private properties.

c. Skovron reports that Greg Overton, Nature Conservancy, has been working with Greg Marlowe (Century Aggregates) on a plan of management to protect the rare insect and plant species on his property. P&Z helps monitor the legal stipulation between the Town, neighbors, and Century Aggregates Sand Road Quarry, so the report is of interest to the Commission and with regard to possible future requests by the Conservancy for habitat management of the quarry buffer zone.

d. Increase of P&Z membership was moved to New Business by consensus.

New Business:
There was discussion of increasing the number of regular members on P&Z to eight and reducing the member of alternates to two in order to form adequate sub-committees from the regular members to take care of *ongoing* business such as:

a. Review of the Conservation and Development Plan
b. Review of the Zoning Regulations
c. Review of the Sub-Division regulations
d. Attendance of COG and LCEO-sponsored zoning and land-use planning related workshops and meetings.

RECEIVED
MAY 31 2006
9:10AM
TOWN OF CANAAN

This proposed change would be brought before the June 12, 2006 BOS Meeting for consideration and possible vote at the June 20, 2006 Town Meeting, upon BOS recommendation. There was discussion about what constitutes a majority and quorum for certain types of land-use issues with the proposed change of regular membership. Opinion of Town Counsel may be sought regarding this.

G. Bidou moved to recommend to the Town a change in the make-up of the P&Z Commission from seven (7) Regular Members/ three (3) Alternates to eight (8) Regular Members/ two (2) Alternates. R. Skovron seconded. Passed unanimously.

R. Skovron moved to recommend to the BOS the appointment of Alternate Stephen Koshland to become the eighth Regular Member of the Canaan P&Z Commission. J. Bronson seconded. Passed unanimously.

R. Skovron will write letters to the BOS regarding these two motions for their consideration.

Old Business:
Chairman Laser reports that regarding the Camp Freidman application for a special permit, a presentation to the Inland Wetlands Commission has not taken place yet, so needed IWC approval is still pending.

Other Business:
a. ZEO Michael O'Neil showed the proposed subdivision map drawings by Allied Engineering Assoc., LLC submitted by Edward Calandro for his Undermountain Road property. O'Neil pointed out some confusing elements and inconsistencies in certain drawings that require clarification, i.e. road frontage, a shared driveway (length, width, slope) vs. what is shown on the tax assessors map, which lot will use a certain existing septic tank, discrepancy between drawings and TAHD references, and references to old zoning regulations. There does not appear to be an A-2 stamped survey.
A motion was made by J. Bronson to accept the subdivision application from Edward Calandro, 16 Undermountain Road. A. Orr-Andrawes seconded. Passed unanimously.
The ZEO is asked to inform the applicant's engineer of the issues discussed and the need to refer to the new Zoning Regulations.

b. A motion was made by J. Bronson to recommend that the Town of Canaan P&Z in coordination with the Board of Selectmen host a public seminar on the NW Highlands Project and specifically invite area Inland Wetland and Planning and Zoning Commissions, as well as the general public. R. Skovron seconded. R. Skovron and D. Shaw will work together on a letter to the First Selectman regarding the P&Z recommendation on this seminar.

Adjournment:
Motion to adjourn at 8:58 p.m. by A. Orr Andrawes. G. Bidou seconded. Passed unanimously

Respectfully submitted,
Margo Lewis
Margo B. Lewis, Recording Secretary

EXHIBIT
IJ31

January 5, 2006

Open Space Acquisition Program
Department of Environmental Protection
79 Elm Street
Hartford, CT 06106-5127

Open Space Acquisition Program:

We are writing to draw your attention to what we believe is the most significant ecological community in the State of Connecticut and arguably one of the most important conservation targets in the Northeast: the limestone ridge system (often referred to as Point of Rocks) west of Sand Road in the towns of Falls Village and Canaan.

We are both professors in the Ecology and Evolutionary Department at the University of Connecticut, Co-directors of the University's Center for Conservation and Biodiversity, and serve on the Board of the Connecticut Chapter of the Nature Conservancy. DLW also serves (chairs) on the Connecticut's Advisory Committee for Rare Invertebrate Species.

Five state-listed species invertebrates occur at the Point of Rocks-Sand Road site—see Table 1. Both the endangered butterflies on the site, the Columbine Duskywing (*Erynnis lucillius*) and Northern Metalmark (*Calephalis borealis*) are regionally rare and declining. The largest populations of these two butterflies in the Northeast occur about the limestone quarries along Sand Road. The Northern Metalmark is a G3 (NatureServe 2005), and thus of global conservation concern. If we knew the ground fauna well--snails, ground beetles, ground-nesting bees--many other conservation targets would be found. The Columbine Stalk Borer (*Papaipema leucostigma*) was thought to be extirpated in the state until recently, when a specimen was found in a box of moths at the University of Connecticut collected at the Red Wing quarry in 2002.

Table 1. Rare insects known from Point of Rocks.

Common Name	Scientific Name	State Status	Hostplant
Columbine Duskywing Butterfly	*Erynnis lucillius*	Endangered	columbine
Northern Metalmark	*Calephelis borealis*	Endangered	roundleaf groundsel
Columbine Stalk Borer	*Papaipema leucostigma*	Special Concern (historic)(recently rediscovered)	columbine
Tawny Emporer	*Asterocampa clyton*	Special Concern	hackberry
Hackberry Butterfly	*Asterocampa celtis*	Special Concern	hackberry

The plants tell a similar story. Six state-listed species are known from Point of Rocks, one of which is found nowhere else in Connecticut. This sedge *Carex backii*, was until recently considered historic in Connecticut, known only from dry marble ridges. This plant is considered imperiled throughout much on the northeastern United States and adjacent Canada. State-listed species are listed in Table 2.

Table 2. Rare plants known from Point of Rocks.

Common Name	Scientific Name	State Status
Spiked False Oats	*Trisetum spicatum* var. *molle*	Special Concern
Sedge	*Carex backii*	Endangered
Eastern few-fruited sedge	*Carex oligocarpa*	Special Concern
Wallrue spleenwort	*Asplenium ruta-muraria*	Threatened
Slender wheatgrass	*Elymus trachycaulus* ssp. *subsecundus*	Special Concern
Northern White Cedar	*Thuja occidentalis*	Threatened

In addition Dr. Bernard Goffinet and a group of bryologists and lichenologists on a field trip discovered two "plants" new to Connecticut at Point of Rocks in 2002. One of these, a moss, *Neckera besseri*, was previously known from many sites across eastern North America and Europe, but had not been reported from New England. The lichen, *Agonimia opuntiella* was known from Europe and only a few sites in the south and southwestern part of the United States--it had not been previously reported north of New Jersey.

We are writing to encourage the State to take every measure to acquire any properties along the limestone ridge system west of Sand Road in Canaan and Falls Village. The south-facing slopes along the southern half of the ridge system are especially unique and worthy of immediate protection. Please feel free to contact us you feel that we might be able to assist further. Thank you.

Sincerely,

Dr. David L. Wagner, Co-Director
Center for Conservation and Biodiversity
University of Connecticut

Dr. John Silander, Co-Director
Center for Conservation and Biodiversity
University of Connecticut

cc The Connecticut Chapter of the Nature Conservancy
Town of Falls Village
Town of North Canaan
Town of Salisbury

Butterflies and Moths of North America

Occurrence maps, species accounts, checklists, and photographs

Blumberg No. 5136
EXHIBIT
IJ32

Announcement

We are seeking
killed lepidopterists
to serve as state
coordinators.
Find out more.

Species Detail

Columbine Duskywing (*Erynnis lucilius*)

Columbine Duskywing © Peter Hall

Attributes of *Erynnis lucilius*

Family: Skippers (*Hesperiidae*)

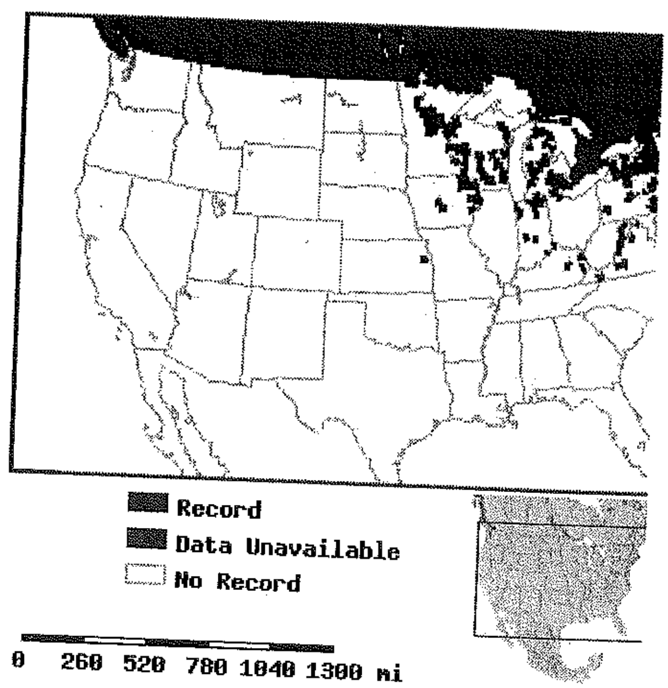
Subfamily: Spread-wing Skippers (*Pyrginae*)

Identification: Upperside is dark brown; brown patch at end of forewing cell is indistinct. Underside of hindwing has marginal and submarginal rows of well-defined pale spots. Male has a costal fold containing yellow scent scales; female has a patch of scent scales on the 7th abdominal segment.

Life history: Females deposit eggs singly under leaves of the host plant. Caterpillars feed on leaves and rest in shelters of leaves. Fully-grown caterpillars from the second brood hibernate.

Flight: Two broods from April-September.

Documented Records for *Erynnis lucilius*



Display alternate map

North Americ

Wing span: 1 3/16 - 1 5/8 inches (3 - 4.2 cm).

Caterpillar hosts: Wild columbine (Aquilegia canadensis) and sometimes garden columbine (A. vulgaris) in the buttercup family (Ranunculaceae).

Adult food: Flower nectar.

Habitat: Rocky deciduous or mixed woodland and edges, especially in ravines or gullies.

Range: Southern Quebec and southern New England west to Minnesota; south to New Jersey and Pennsylvania; south along the Appalachians to Virginia and Kentucky. Comments: The Columbine, Wild Indigo, and Persius dusky wings belong to the "Persius complex," a confusing group of very similar butterflies.

Conservation: Not usually required.

The Nature Conservancy Global Rank: G4 - Apparently secure globally, though it might be quite rare in parts of its range, especially at the periphery.

Management needs: None reported.

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Butterflies and Moths of North America

Occurrence maps, species accounts, checklists, and photographs

Blumberg No. 5136
EXHIBIT
IJ33

Announcement

We are seeking skilled lepidopterists to serve as state coordinators.
Find out more.

Species Detail

Northern Metalmark
(*Calephelis borealis*)

Attributes of *Calephelis borealis*

Family: Metalmarks (*Riodinidae*)

Identification: Male forewing rounded. Upperside of both wings brown with wide orange borders and dark median band.

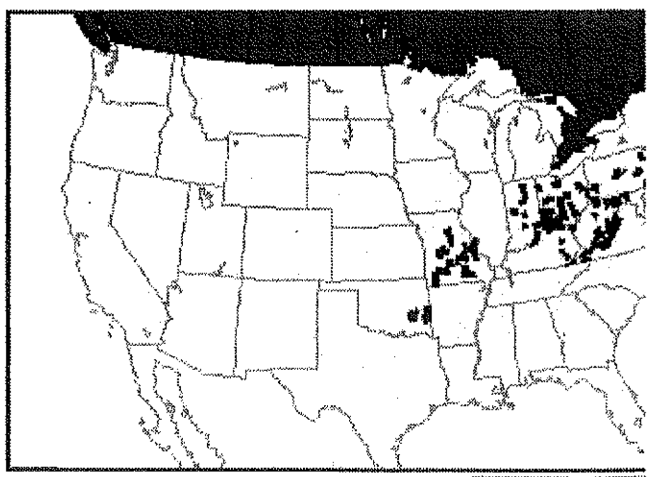
Life history: Adults may rest upside down beneath leaves. Males perch on leaves to seek females. Eggs are laid on the underside of host plant leaves, which the caterpillars eat. Half-grown caterpillars hibernate in leaf litter.

Flight: One brood from mid-June to late July.

Wing span: 1 1/8 - 1 1/4 inches (2.9 - 3.2 cm).

Caterpillar hosts: Roundleaf ragwort (Senecio obovatus); possibly golden ragwort (Senecio aureus) and common fleabane

Documented Records for *Calephelis borealis*



Record
Data Unavailable
No Record

0 260 520 780 1040 1300 mi

Display alternate map

North Amer

(Erigeron philadelphicus).

Adult food: Nectar from flowers including butterflyweed, white sweet clover, goldenrod, ox-eye daisy, sneezeweed, and yarrow.

Habitat: Open woodland streams near serpentine, shale, or limestone barrens.

Range: Western Connecticut south through west-central Pennsylvania; central Appalachians and Ohio River Valley. Isolated populations in southwest Missouri and eastern Oklahoma.

Conservation: Most populations are small and isolated. Almost all populations should be of concern.

The Nature Conservancy Global Rank: G3 - Very rare or local throughout its range or found locally in a restricted range (21 to 100 occurrences). (Threatened throughout its range).

Management needs: None reported.

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Blumberg No. 5136 EXHIBIT IJ 34

ORIGINAL ARTICLE

Subjective symptoms, sleeping problems, and cognitive performance in subjects living near mobile phone base stations

H-P Hutter, H Moshammer, P Wallner, M Kundi

Occup Environ Med 2006;**63**:307–313. doi: 10.1136/oem.2005.020784

See end of article for authors' affiliations

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Accepted 11 November 2005

Background: The erection of mobile telephone base stations in inhabited areas has raised concerns about possible health effects caused by emitted microwaves.
Methods: In a cross-sectional study of randomly selected inhabitants living in urban and rural areas for more than one year near to 10 selected base stations, 365 subjects were investigated. Several cognitive tests were performed, and wellbeing and sleep quality were assessed. Field strength of high-frequency electromagnetic fields (HF-EMF) was measured in the bedrooms of 336 households.
Results: Total HF-EMF and exposure related to mobile telecommunication were far below recommended levels (max. 4.1 mW/m^2). Distance from antennae was 24–600 m in the rural area and 20–250 m in the urban area. Average power density was slightly higher in the rural area (0.05 mW/m^2) than in the urban area (0.02 mW/m^2). Despite the influence of confounding variables, including fear of adverse effects from exposure to HF-EMF from the base station, there was a significant relation of some symptoms to measured power density; this was highest for headaches. Perceptual speed increased, while accuracy decreased insignificantly with increasing exposure levels. There was no significant effect on sleep quality.
Conclusion: Despite very low exposure to HF-EMF, effects on wellbeing and performance cannot be ruled out, as shown by recently obtained experimental results; however, mechanisms of action at these low levels are unknown.

Hand-held cellular telephones were introduced in the early 1980s. Due to the relatively high microwave exposure for users while they are on the telephone, the potential health effects of mobile phones have been studied in recent years. However, exposure to the much lower emissions from mobile phone base stations has been neglected. There have been only two observational pilot investigations,[1-2] and one experimental study.[3]

The World Health Organisation (WHO)[4] has recently recommended investigating the effects of exposure to emissions from mobile phone base stations to address public concerns.

It has often been argued that if there are detrimental long term effects from high-frequency electromagnetic fields (HF-EMF) as transmitted by mobile phone base stations, then such effects should have been found near powerful radio and television transmitters. This argument is invalid as: (1) there are very few studies on effects from radio and TV transmitters, ecological and cluster studies on cancer,[5-10] and studies on sleep and other endpoints;[11-12] (2) the results of these studies are compatible with the assumption of a moderately elevated risk; and (3) emissions from base stations differ substantially from those of other sources of HF-EMF.

There are numerous reports from physicians that base stations are associated with a number of health symptoms in neighbours. However, these symptoms might be due to fear about negative effects. Nevertheless there is evidence that long term, low level exposure to HF-EMF may result in a number of symptoms (for example, headaches, fatigue, sleep disorders, memory impairments),[13] attributed as microwave sickness syndrome.[14]

This study investigated the relation between exposure from mobile telecommunication and other sources of HF-EMFs and the associations between exposure and symptoms.

METHODS

Selection of base stations

The study covers urban as well as rural areas in Austria. The city of Vienna was selected as the urban area while villages in Carinthia represented the rural areas. Two network providers were each asked to identify about five base stations within both regions that fulfilled the following requirements:

- The antenna must have been operating for at least two years
- There had been no protests by neighbours against the base station
- There was no other base station nearby (this could only be achieved in rural areas)
- Transmission was preferably only in the 900 MHz band.

Twenty one base stations were specified, from which 10 were selected for the study based on inspection of the local conditions (population density, other sources of exposure).

Selection of study area and participants

Data from the 10 selected antenna locations, including the antenna diagram, were provided by the network companies. In order to ensure a sufficient gradient of exposure, these data were used to define the study area around the selected base station. The investigation was carried out by trained students and a medical technical assistant in Carinthia and

Abbreviations: ANCOVA, analysis of covariance; BCCH, broadcast channel; CI, confidence interval; GSM, global system for mobile telecommunication; HF-EMF, high-frequency electromagnetic fields; MHz, megahertz; POR, prevalence odds ratio; SAR, specific (energy) absorption rate; SD, standard deviation; TDMA, time division multiple access; WHO, World Health Organisation

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Table 1 Demographic characteristics of subjects by exposure category

	Exposure category (mW/m²)			
	<0.1	0.1–0.5	>0.5	p value
Age	45 (SD 16)	40 (SD 14)	44 (SD 15)	0.390
Females	60%	58%	56%	0.829
Years of residence	19 (SD 16)	17 (SD 13)	20 (SD 16)	0.403
Hours at home	10 (SD 5)	10 (SD 4)	10 (SD 5)	0.413
Employed	56%	60%	61%	0.689
Urban residence	55%	42%	49%	0.171
Education > 12 y	42%	38%	40%	0.784
Mobile phone use	75%	77%	78%	0.866

p value from Kruskal–Wallis or χ^2 test.

Vienna. Based on power calculations, the projected number was 36 subjects for each of the 10 locations.

In Vienna, households were randomly selected from telephone register entries. Subjects were contacted by telephone. If after three attempts no contact could be achieved, the next entry in the telephone list was chosen. Subjects were told that the relationship between environmental factors and health would be investigated. They had to be older than 18 years, have been living in their present house for at least one year, and been staying there for a minimum of eight hours a day on average. Refusal was slightly above 40% and mainly due to time constraints. On acceptance of participation an appointment was made for a visit. In Carinthia the procedure was different because no clear relation of address to study area could be ensured (houses are not always numbered consecutively). Therefore a random selection of houses based on the site plan was performed. Investigators contacted subjects directly in their homes. In the case of acceptance, either an appointment for the investigation was made or it was carried out immediately. Rate of refusal was somewhat lower than in the urban area (32%). On contact, gender, age, and duration of residence in their present house (eligibility criteria) were registered. Non-participants were insignificantly more frequently males (47% v 41%) and significantly younger (40 v 44 years), and had a significantly shorter time living in their present house (13 v 16 years).

Data collection and measurements

All investigations were done in the homes of the subjects using a laptop computer. Performance tests as well as questionnaires were presented along with instructions on the screen. Handling was so simple that after a short introduction all subjects were able to fulfil the tasks without further assistance by the investigators. The investigation consisted of the following:

- Sociodemographic data, sources of EMF exposure within the household, regular use of mobile telephones.
- Evaluation of environmental quality, subjective scaling of the impact different environmental factors could have on the health of the subjects. Among the items listed were traffic noise, particulate matter, and mobile phone base station. Assumed impact was rated on a five point scale from 0 = not at all, to 4 = very strong impact.
- Subjective scaling of symptoms (Zerssen scale).[15] Symptoms were rated on a four point scale from 0 = not at all, to 3 = strong. Symptoms of special interest were headaches, symptoms of exhaustion, and circulatory symptoms (see table 4). For analysis, ratings were dichotomised (0/1–3).
- Investigation of sleeping problems (Pittsburgh sleeping scale).[16] Problems falling asleep and staying asleep were rated by the participants on a frequency scale ranging from never to more than 3 days a week. The global index is

Table 2 Exposure categories and results of analysis of covariance for tests of cognitive performance

	Exposure category (mW/m²)			
Test	<0.1	0.1–0.5	>0.5	p value
Memory				
Immediate memory*	6.2 (1.4)	5.6 (1.4)	5.9 (1.5)	0.166
Short term memory (1 min)†	29.1 (4.3)	29.5 (4.1)	29.3 (3.9)	0.354
Short term memory (5 min)†	33.9 (2.9)	33.1 (3.1)	34.0 (1.9)	0.761
Short term memory (15 min)†	33.4 (2.9)	33.6 (2.4)	33.7 (2.0)	0.883
d′ (1 min)‡	0.87 (0.48)	0.88 (0.42)	0.86 (0.41)	0.737
d′ (5 min)‡	1.54 (0.39)	1.48 (0.62)	1.53 (0.32)	0.579
d′ (15 min)‡	1.56 (0.39)	1.54 (0.32)	1.62 (0.27)	0.198
ln β (1 min)§	−0.34 (0.45)	−0.19 (0.32)	−0.29 (0.30)	0.235
ln β (5 min)§	−1.09 (0.58)	−1.11 (0.72)	−1.04 (0.54)	0.605
ln β (15 min)§	−1.36 (0.53)	−1.21 (0.52)	−1.47 (0.53)	0.095
Perceptual speed				
Speed score (sec)	4.3 (0.9)	4.0 (1.1)	3.8 (1.0)	0.061
Items solved (max. 8)	4.6 (2.4)	4.1 (2.3)	4.1 (2.5)	0.147
Choice reaction task				
Reaction time (msec)	582 (217)	511 (139)	585 (244)	0.485

Results expressed as mean (SD).
p values for exposure factor are shown.
*Highest number of correctly reproduced digits.
†Number of correctly identified items (sum of correct detections (from 20) and correct rejections (from 20 distraction items)).
‡d-prime from signal detection analysis.
§Natural logarithm of detection bias beta.

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computed as the sum of seven sub-scales (see table 5) with each component scored 0 to 3 (higher score indicates greater problems).

- Cognitive performance.
  - Memory tasks consisted of a short term memory test using 1–10 digit numbers that had to be reproduced immediately after presentation. The score was defined as the highest number of digits correctly reproduced. The assessment of medium term memory was based on 20 simple everyday objects in silhouette drawings presented together for 30 seconds on the screen. After 1, 5, and 15 minutes these items together with 20 distraction items (different for the three tests) were presented in random sequence, one at a time, and the subjects had to decide whether or not the picture was among those presented. Each response was followed by immediate feedback. After each test all objects were again presented for 15 seconds. The score was defined as the number of correct responses. In addition, d-prime and response bias (beta) from signal detection analysis were computed (d-prime is the normalised distance between the signal and noise answer distributions, the higher the d-prime, the less likely is confusion between target and distraction items; beta measures the bias to respond "yes" whether it is a target or distraction item).
  - The choice reaction task consisted of a random sequence of squares of three different colours (red, green, and yellow) appearing at random locations on the screen. Subjects had to react as fast as possible by pressing a specified button for each colour. The score was defined as the average correct reaction time across 25 trials.
  - Perceptual speed was tested by presenting two series of 10 letters ("meaningless words") that differed at exactly one position. Eight of these double series were presented in random sequence. Subjects had to find the differing letter under time constraints (maximum 6 seconds) and place a cursor below it. These position varied between the 3rd and 7th letters. Score was defined as the average time to achieve the correct solution. In addition, the number of items solved within the time window was computed.

After completion of the questionnaires and tests, dates were arranged for exposure measurements. Measurements of high frequency EMFs were done by a specialist from a certified centre in Vienna (TGM). A biconic field probe (PBA 10200, ARC Seibersdorf) was used connected to a spectrum analyser (FSP, Rhode & Schwarz). Measurements were performed in the bedroom (this being typically the only place in the house where people consistently spend many hours a day). As exposure may vary at this location, in addition to the sum of power densities across all mobile phone frequencies, the maximum exposure from the base station was computed based on measurements of broadcast channels. Broadcast channels (BCCH) operate all the time at maximum power with all time slots occupied. Hence multiplication of measurements of BCCH by the ratio of the sum of the power of all channels to that of the BCCH results in maximum possible exposure level, while the sum of BCCH measurements gives the minimum. The former is the result of all channels operating at maximum power with all time slots occupied, while the latter occurs if no traffic channel is active.

Distance from the antenna was calculated based on the coordinates of the measurement location and the base station. It ranged between 24 m and 600 m in rural areas and between 20 m and 250 m in urban areas. The smaller range in the latter was due to the vicinity of other base stations and the shadowing effect of high buildings.

Subjects

In total, 365 subjects were investigated (185 in Vienna and 180 in Carinthia). In some cases EMF measurements were not possible due to the absence of the inhabitants at the arranged date. Therefore, only data from 336 subjects could finally be evaluated.

Subjects were between 18 and 91 years of age (mean 44, SD 16 years). Fifty nine per cent were female. Average duration of residence in the house was 19 (SD 16) years, and subjects stayed for 10 (SD 5) hours a day in the immediate neighbourhood. Overall, six subjects occupied the place only after erection of the base station. All subjects slept normally at home.

Statistical analysis

Statistical evaluation of exposure from the base stations was done by analysis of covariance (ANCOVA) for components of the Pittsburgh Sleeping Scale and performance measurements, and by logistic regression analysis for subjective symptoms based on the following procedure. First the maximal power density estimates from base station frequencies were classified into three groups: $\leqslant 0.1$ mW/m^2 (approximately up to median), 0.1–0.5 mW/m^2 (between median and 3rd quartile), and >0.5 mW/m^2. Originally it was planned to define four exposure categories based on quartiles. However, it turned out that the level of exposure was too low for the two lowest exposure categories to be meaningfully discriminated and consequently these categories were combined. Average exposure levels were 0.04 mW/m^2, 0.23 mW/m^2, and 1.3 mW/m^2, respectively. Exposure level, area (rural *v* urban), and interaction were included as fixed factors, age, sex, regular use of a mobile telephone, and the subjective rating of negative consequences of the base station on health were used as covariables. Normality was assessed by Kolmogorov–Smirnov tests using Lilliefors p values, homogeneity of variance by Levene's tests. For all analyses the model with separate slopes was first tested. If none of the interactions with fix factors were significant at the 10% level, the model with homogenous slopes was computed. In addition, homogeneity of variance–covariance matrices of covariables and dependent variables across groups was tested by Box M tests. Unconditional logistic regression was performed using the same covariables. For all tests a p value below 0.05 was considered significant. No correction for multiple testing was applied.

RESULTS

Table 1 gives an overview of features of participants across exposure categories. Although none of the variables reached statistical significance, the somewhat higher proportion of subjects from the urban area in the lowest exposure category should be noted.

Exposure to high frequency EMFs was generally low and ranged from 0.0002 to 1.4 mW/m^2 for all frequencies between 80 MHz and 2 GHz; the greater portion of that exposure was from mobile telecommunications (geometric mean 73%), which was between 0.00001 and 1.4 mW/m^2. Maximum levels were between 0.00002 and 4.1 mW/m^2. Overall 5% of the estimated maximum exposure levels were above 1 mW/m^2. Average exposure levels were slightly higher in the rural area (0.05*/7.6 mW/m^2) than in the urban area (0.02*/7.1 mW/m^2).

Most subjects expressed no strong concerns about adverse health effects of the base station. In the urban and rural test areas, 65% and 61% respectively stated no concerns at all.

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Main messages

- Exposure from mobile phone base stations is orders of magnitude below current guideline levels.
- Self-reported symptoms like headache and difficulties in concentrating show an association with microwave exposure from base stations, not attributable to subjects' fear of health effects from these sources.
- Other symptoms, like sleeping problems, seem to be more due to fear of adverse health effects than actual exposure.

at least two years. Furthermore, it was important that no other base station was nearby (which, however, could only be achieved in rural areas).

Because of the much higher exposure during telephoning compared to exposure from base stations, it is hardly conceivable that such small additional exposure could have an effect. However, these exposures have fundamentally different features. Exposure from the base station will be at low, but more or less constant levels for many hours a day, especially during the night. Comparing these levels is inappropriate if long term effects actually exist. If, for example, a subject is using a GSM mobile with a specific energy absorption rate (SAR) of 0.04 W/kg[20] for 10 minutes, this would be roughly equivalent to a 15 day exposure from a base station at an exposure level of 1 mW/m^2 if the principle of time–dose reciprocity is valid. However, it is not known whether this principle holds for exposure to HF-EMFs.

There is no a priori argument why the much lower levels from base stations should have no effect in the presence of widespread use of mobile telephones. Possible confounding by using a mobile has been considered in this study.

Generally, ratings were higher for most symptoms in subjects expressing concerns about health effects from the base station. Subjects who experience health problems might search for an explanation in their environment and blame the base station; another explanation would be that subjects with concerns are more anxious and also tend to give a more negative view of their body functions, or that some people generally give quite negative answers. Irrespective of these explanations there seem to be effects of exposure that occur independently of the fear of the subjects about the base station affecting their health. This is the case for headaches, cold hands or feet, and difficulties in concentrating, for example. These effects were robust with respect to additional potential confounders (for example, for headaches, inclusion of an indicator of socioeconomic status—years of education and type of occupation—slightly increased the risk estimator for exposure and decreased the p value from 0.017 to 0.016; inclusion of years of living in the present home and overall rating of environmental quality slightly increased the p value to 0.019; inclusion of hours staying at home did not change effect estimates at all). Interestingly these symptoms as well as some others that tended to be increased at higher exposure levels belong to those attributed to the microwave sickness syndrome. However, no clear relationship has been found for sleeping problems that are often mentioned in the public debate. The effect on sleep is dominated by concerns of the subjects of negative health effects of the base station. Many factors are known to influence sleep quality. Only a few could be considered in this study. Since some aspects of sleep quality, like sleep efficiency, showed a tendency for being affected by exposure, future studies should attempt to eliminate additional confounders.

Policy implications

- Despite very low emissions from mobile phone base stations, more research concerning the effects of radiofrequency radiation from base stations is indicated.
- As a precautionary measure, siting of base stations should be such as to minimise exposure of neighbours.

Concerning symptom reporting there are a number of personality factors for which an association has been established. Among these are state anxiety, depression, and negative affectivity. The main question concerning this range of factors is whether they might act as confounders. In discussions of the microwave sickness syndrome, depression has also been mentioned among the possible effects of exposure; confounding is therefore conceivable. Sleep quality, unspecific symptoms, depression, affectivity, and other personality characteristics are connected with each other in a network of relationships such that a clear understanding of the possible long term effects of exposure may only be determined by longitudinal studies.

No influence of the subjects' fear about negative effects of the base station was found for cognitive performance. There was a small but significant reduction of reaction time for perceptional speed at increased exposure levels. It is interesting to note that such facilitating effects have also been reported during short term experimental exposures[20 22] and a study in teenagers using mobile phones.[21] On the other hand, a study[12] in children chronically exposed to emissions from a radio tower reported increased reaction times and reduced performance in cognitive tasks. We found a reduction of reaction time in adults, but an insignificant decrease of accuracy. Recognition in the medium term memory task showed a reasonable and increasing differentiation between target and distraction items and a decreasing response bias over repeated tests, but there was no indication of an influence of exposure from the base station. Furthermore, cognitive performance varies with factors that have not been controlled or considered in this study. Indices of socioeconomic status, however, were tested and did not modify effect size of base station exposure.

The results of this study indicate that effects of very low but long lasting exposures to emissions from mobile telephone base stations on wellbeing and health cannot be ruled out. Whether the observed association with subjective symptoms after prolonged exposure leads to manifest illness remains to be studied.

ACKNOWLEDGEMENTS

This study was supported by the Scientific Medical Funds of the Mayor of the City of Vienna and the Government of the County of Carinthia. The assistance of Dr M LMathiaschitz, Mrs G Pridnig, and Mrs B Piegler is gratefully acknowledged.

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Competing interests: none

REFERENCES

1 **Santini R**, Santini R, Le Ruz P, *et al*. Survey study of people living in the vicinity of cellular phone base stations. *Electromagnetic Biology and Medicine* 2003;**22**:41–9.

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2 **Navarro EA**, Segura J, Portosolés M, *et al*. The microwave syndrome: a preliminary study in spain. *Electromagnetic Biology and Medicine* 2003;**22**:161–9.
3 **Zwamborn A**, Vossen S, van Leersum S, *et al*. *Effects of global communication system radio-frequency fields on well being and cognitive functions on human beings with and without subjective health complaints. TNO-report FEL-03-C148*. The Hague: TNO Physics and Electronic Laboratory, 2003.
4 **World Health Organisation**. International EMF Project, Agenda for research. http://www.who.int/peh-emf/research/agenda/en (accessed 13 June 2004).
5 **Hallberg Ö**, Johansson O. Melanoma incidence and frequency modulation (FM) broadcasting. *Arch Environ Health* 2002;**57**:32–40.
6 **Dolk H**, Shaddick G, Walls P, *et al*. Cancer incidence near radio and television transmitters in Great Britain, Part I. Sutton Coldfield Transmitter. *Am J Epidemiol* 1997;**145**:1–9.
7 **Dolk H**, Elliot P, Shaddick G, *et al*. Cancer incidence near radio and television transmitters in Great Britain, Part II. All high-power transmitters. *Am J Epidemiol* 1997;**145**:10–17.
8 **Hocking B**, Gordon IR, Grain ML, *et al*. Cancer incidence and mortality and proximity to TV towers. *Med J Aust* 1996;**165**:601–5.
9 **Maskarinec G**, Cooper J, Swygert L. Investigation of increased incidence in childhood leukemia near radio towers in Hawaii: preliminary observations. *J Environ Pathol Toxicol Oncol* 1994;**13**:33–7.
10 **Selvin S**, Schulman J, Merrill DW. Distance and risk measures for the analysis of spatial data: a study of childhood cancers. *Soc Sci Med* 1992;**34**:769–77.
11 **Altpeter E**, Battaglia M, Bader A, *et al*. Ten years experience with epidemiological research in the vicinity of the short-wave broadcasting area Schwarzenburg: what does the story tell us? *Proceedings of the International Conference on Cell Tower Siting*. Salzburg, Austria, 7–8 June, 2000:127–32.
12 **Kolodynski AA**, Kolodynska VV. Motor and psychological functions of school children living in the area of the Skundra Radio Location Station in Latvia. *Sci Tot Environ* 1996;**180**:87–93.
13 **Silverman C**. Nervous and behavioral effects of microwave radiation in humans. *Am J Epidemiol* 1973;**97**:219–24.
14 **Johnson Liakouris AG**. Radiofrequency (RF) sickness in the Lilienfeld study: an effect of modulated microwaves? *Arch Environ Health* 1998;**53**:236–8.
15 **Zerssen D v, Koeller DM**. Die Befindlichkeitsskala. Testzentrale Göttingen. 1976.
16 **Buysse DJ**, Reynolds III CF, Monk TH, *et al*. The Pittsburgh sleep quality index: a new instrument for psychiatric practice and research. *Psychiat Res* 1989;**28**:193–213.
17 **International Commission on Non-Ionizing Radiation Protection**. Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz). *Health Phys* 1998;**74**:494–522.
18 **Hamnerius I**, Uddmar Th. Microwave exposure from mobile phones and base stations in Sweden. *Proceedings of the International Conference on Cell Tower Siting*. Salzburg, Austria, 7–8 June, 2000:52–63.
19 **Mann SM**, Cooper TG, Allen SG, *et al*. *Exposure to radio waves near mobile phone base stations*, NRPB-R321, 2000.
20 **Persson T**, Törnevik C, Larsson LE, *et al*. GSM mobile phone output power distribution by network analysis of all calls in some urban, rural and in-office networks, complemented by test phone measurements. *24th Meeting of the Bioelectromagnetics Society*. Quebec, Canada, June, 2002:181–3.
21 **Edelstyn N**, Oldershaw A. The acute effects of exposure to the electromagnetic field emitted by mobile phones on human attention. *Neuroreport* 2002;**13**:119–21.
22 **Lee T**, Ho S, Tsang L, *et al*. Effect on human attention of exposure to the electromagnetic field emitted by mobile phones. *Neuroreport* 2001;**12**:729–31.
23 **Preece AW**, Iwi G, Davies Smith A, *et al*. Effect of a 915-MHz simulated mobile phone signal on cognitive function in man. *Int J Radiat Biol* 1999;**75**:447–56.

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IJ95

ELECTROMAGNETIC BIOLOGY AND MEDICINE
Vol. 22, No. 1, pp. 41–49, 2003

Survey Study of People Living in the Vicinity of Cellular Phone Base Stations

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ABSTRACT

A survey study was conducted, using a questionnaire, on 530 people (270 men, 260 women) living or not in proximity to cellular phone base stations. Eighteen different symptoms (Non Specific Health Symptoms–NSHS), described as radiofrequency sickness, were studied by means of the chi-square test with Yates correction. The results that were obtained underline that certain complaints are experienced only in the immediate vicinity of base stations (up to 10 m for nausea, loss of appetite, visual disturbances), and others at greater distances from base stations (up to 100 m for irritability, depressive tendencies, lowering of libido, and up to 200 m for headaches, sleep disturbances, feeling of discomfort). In the 200 m to 300 m zone, only the complaint of fatigue is experienced significantly more often when compared with subjects residing at more than 300 m or not exposed (reference group). For seven of the studied symptoms and for the distance up to 300 m, the frequency of reported complaints is significantly higher ($P<0.05$) for women in comparison with men.

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DOI: 10.1081/JBC-120020353
1536-8378 (Print); 1536-8386 (Online)
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Significant differences are also observed in relation to the ages of subjects, and for the location of subjects in relation to the antennas and to other electromagnetic factors.

Key Words: Cellular phone base stations; Bio-effects.

INTRODUCTION

Chronic exposure to ultra-high-frequency electromagnetic fields or microwaves brings on bioeffects in man such as headaches, fatigue, sleep, and memory disturbances (Bielski, 1994; Santini, 1999). These biological effects, associated with others (skin problems, nausea, irritability) constitute what is known as "Non Specific Health Symptoms" (NSHS) that characterize radiofrequency sickness (Johson Liakouris, 1998). Cellular mobile phone technology uses microwaves (frequencies of 900 or 1800 MHz in France) pulsed with extremely low frequencies (frequencies <300 Hertz) (Linde and Mild, 1997). However many of the biological effects resulting from mobile phone use are relatively well-known and bring to mind those described in radiofrequency sickness (Mild et al., 1998; Santini et al., 2002).

We are reporting here the results concerning 530 people living in France, in the neighborhood or not, of cellular phone base stations, in relation to their exposure conditions to antennas, their sex, and their age.

MATERIALS AND METHODS

Questionnaire Used

A questionnaire similar to that developed for the study on mobile phone users (Santini et al., 2002) was sent to people wishing to participate in the study. Subjects were enrolled through information given by press, radio, and web sites, about the existence of a study on people living near cellular phone base stations. The questionnaire was filled out by subjects without the presence of a person in charge of the study and was returned (generally by mail) to a person responsible for the study.

General questions pertained to age, sex, estimated distances from base stations (less than 10 m, 10–50 m, 50–100 m, 100–200 m, 200–300 m, more than 300 m) and their location in relation to the antennas (facing, beside, behind, beneath in the case of antennas placed on rooftops). The exposure conditions of subjects were also defined by the length of time living in the neighborhood of base stations (less than 1 year, 1–2 years, 2–5 years, more than 5 years).

Participants were asked to indicate the presence or not of electrical transformers (at less than 10 m), high or very high tension electric power lines (at less than 100 m) and radio and television transmitters (at less than 4 km). The questionnaire sought information on computer use (more than 2 hours per day) and cellular telephone use (more than 20 minutes per day).

The level of complaints for the studied symptoms was expressed by the study participants using a scale of: 0 = never, 1 = sometimes, 2 = often, and 3 = very often. Of 570 questionnaires received, 40 were not used because of lack of information on the distance from the base stations or on the level of the complaints experienced. Among the 530 questionnaires studied, 270 came from men (45 years ± 20) and 260 from women (47 years ± 19). Eighteen symptoms referenced in the NSHS were found in the questionnaire; one of which, premature menopause, concerned only women.

Analysis of Results

The results obtained, concerning the frequency of the complaints experienced in relation to responses with 0 = never, were analyzed by the chi-square test with Yates correction (Dabis et al., 1992) by means of a software program (STATITCF, 1987, France). Results were compared with the frequency of complaints of the reference group (subject exposed at >300 m or, living in the vicinity of nonoperating base stations) for incidences of distance and age. The comparisons were done with the frequency of complaints expressed by subjects exposed up to 300 m for length of exposure (comparison to <1 year), for location of subjects (comparison of locations among themselves) and for sex. A $P < 0.05$ was considered significant.

We are presenting here the results tallied with: (1) the influence of subject's exposure conditions to base stations (distance, length of exposure, location in relation to the antennas other electromagnetic factors), and (2) the influence of sex and age of subjects.

RESULTS

Influence of Exposure Conditions

Distance

The 530 study subjects were distributed in the following manner: 19.6% were less than 10 m from cellular phone base station antennas, 26.2% between 10 and 50 m, 13.8% between 50 and 100 m, 9.6% between 100 and 200 m, 10.1% between 200 and 300 m, and 20.7% were at more than 300 m or not exposed; these last subjects were chosen as the reference group.

In comparison with the reference group, the complaints are experienced in a significantly higher way by the subjects located in the distance zones of <10 m to 300m from base stations. Certain symptoms are experienced significantly more often ($P < 0.05$) only in the immediate vicinity of base stations (up to 10 m) and not beyond that: Nausea, loss of appetite, visual disturbances, and difficulty in moving. Significant differences ($P < 0.05$) are observed up to 100 m from base stations for symptoms such as: Irritability, depressive tendencies, difficulties in concentration, loss of memory, dizziness, and lowering of libido. In the zone 100 m to 200 m from base stations, the symptoms of headaches, sleep disruption, feelings of discomfort, and skin problems are again experienced significantly more often ($P < 0.05$) in comparison with the reference group. Beyond 200 m, only the symptom of fatigue is reported at a significantly high frequency ($P < 0.05$) (Table 1). By contrast, no significant effect is demonstrated in relation to distance for the symptom of premature menopause. A significant lowering of libido was reported by subjects living at the distances of less than 10 m, 10–50 m, and 50–100 m from base stations.

Table 1. Influence of distances from cellular phone base stations on the percentages of complaints

	Distances from base stations in meters (m)											
	< 10 m		10–50 m		50–100 m		100–200 m		200–300 m		> 300 m	
Symptoms	2	3	2	3	2	3	2	3	2	3	2	3
Fatigue	76*	72*	63.5*	50.9*	60.6	56.6*	64.2	41.1	66.6*	43.7	40.7	27.2
Irritability	32.8	23.2*	41.7*	25.7*	47.2*	44.1*	25.8	4.1	25	9	18	3.3
Headaches	51*	47.8*	40*	26.1*	40.6*	36.7*	60.7*	31.2*	19.3	0	15.6	1.8
Nausea	14.5*	6.9	8.4	3	5.7	3.8	2.4	4,6	0	2.3	2,1	1.1
Loss of appetite	20.4*	8.3	8	5.5	5	5	6.9	0	4.2	0	3.3	3.3
Sleep disturbances	41.3*	57.1*	41.4*	57.5*	46.9*	58.5*	45.8*	50*	33.3	35.5	13.8	21.1
Depressive tendencies	16,9	26.8*	21.6	19.7*	11.6	24*	16.2	3.1	13.6	2.5	10.3	3.7
Feeling of discomfort	28*	45.4*	25.2*	18.9	30.6*	12.8	15.7*	0	9.7	5.1	2.4	8.1
Difficulties in concentration	39.3	28.8*	37.5	16.6	34.2	26.4*	25	12.5	43.3	5.5	26.7	7.1
Memory loss	27.8	25.4*	29.4	26.6*	37.1*	29*	25	15.6	17.2	11.1	17.9	5.8
Skin problems	18.1*	17.1*	6.6	10.8	11.1*	11.1	13.9*	7.5	8.7	0	1.2	4.6
Visual disturbances	14.5	24.3*	23	13.5	22	7.1	2.5	4.9	15	2.8	13.6	4.1
Hearing disturbances	33.3*	17.4	17.7*	12	8.3	15.5	7.7	7.7	11.6	9.5	5.6	8.7
Dizziness	10	12.5*	17.3*	7,5*	9.6	9.6*	12.2	2.7	7.7	5.2	6.2	0
Movement difficulties	5.6	7.7*	8.2	1.7	3	3	0	0	2	0	2.9	1
Cardiovascular problems	10.1*	13*	15.3*	9.6	12.3*	7.4	8.7	0	8.5	6.5	1	3

for 16 non Specific Health Symptoms experienced by 530 people (270 men + 260 women).

* = $P < 0.05$ in comparison to the reference group (> 300 m) for the responses 2 = often and 3 = very often.

Length of Exposure

There is no significant difference in the frequency of symptoms expressed by subjects living up to 300 m from cellular phone base station, according to the length of time (<1 year to more than 5 years) they have lived in the neighborhood of base stations.

Location of Subjects

The location of subjects in relation to the antennas (facing, beside, behind, beneath) taken alone has little impact on the frequency of symptoms reported. When comparisons are made in relation to the different distance zones, significant increases of complaints ($P < 0.05$) are observed for some distances and for some symptoms in the facing position: visual disturbances for distance <10 m as compared with beneath, fatigue for distance 10 to 50 m as compared with beneath, headache for distance 10 to 50 m as compared with beside, memory loss for distance 50 to 100 m as compared with beside. When comparisons are made for all subjects exposed at a distance of up to 300 m from base stations, it is only observed a significant increase in headaches ($P < 0.05$) for subjects in the beneath position as compared with subjects in the facing position.

Table 2. Influence of sex on the percentages of complaints

Symptoms	Men (%)	Women (%)
Fatigue	41.4	57.5
Irritability	17.9	28.3
Headaches (3)	14.4	45.6*
Nausea (3)	0	5.9*
Loss of appetite (3)	1.9	8*
Sleep disturbances (3)	45.4	61*
Depressive tendencies (3)	9.8	26.7*
Feeling of discomfort (3)	15	25.4*
Difficulties in concentration	18.4	21.6
Memory loss	18	27.7
Skin problems	8	13.1
Visual disturbances (2)	12.2	22*
Hearing disturbances	9.6	19
Dizziness	6	9.8
Movement difficulties	3.3	2.7
Cardiovascular problems	8.3	8.8
Lowering of libido	18	12

for 17 Non Specific Health Symptoms reported by 420 people (205 men vs. 215 women) living in the vicinity of cellular phone base stations (all distances from <10 m to ≤300 m).
* = $P < 0.05$ for level of complaints in parenthesis, 2 = often and 3 = very often.

Exposure to Other Electromagnetic Factors

The presence of factors such as an electrical transformer, very high tension electric power lines, radio-television transmitters, the use of computers, or cellular phones has little influence on the frequency of symptoms reported by subjects living at a distance of up to 300 m from base stations. However, a significant decrease of sleep disturbance for cellular phone users, and significant increases of discomfort and dizziness with the presence of an electrical transformer, and of difficulties in concentration with the presence of a radio-television transmitter, are observed in comparison with subjects living at a distance of up to 300 m, but not exposed to those factors.

Table 3. Influence of age on the percentages of complaints

	≤20 years		21–40 years		41–60 years		>60 years	
	Distances of subjects from antennas (in meters)							
Symptoms	≤300	>300	≤300	>300	≤300	>300	≤300	>300
Fatigue	56.7	62.5	82.4*	25	81.4*	57.8	73.3*	40
Irritability	16.2	11.1	46.2	18.2	50.5	35.3	52.1*	21
Headaches	42.4	26.3	57.6*	18.2	52*	13,3	49.5*	10
Nausea	2	0	12.9	0	9.9	0	15.6	15.7
Loss of appetite	13.3	8.8	12.7	0	11.8	0	15.9	15
Sleep disturbances	26.1	14.8	53*	12,5	73.9	52.6	68.5*	44.4
Depressive tendencies	10.2	5.7	14	5.8	36	20	41.7	27.7
Feeling of discomfort	4.4	2.9	26.3	6	41.6	16.6	45*	19
Difficulties in concentration	30.3	40	42.1	18.7	45.8	36.8	53.3*	20
Memory loss	7.5	8	21.8	6.6	43	40	64	36.8
Skin problems	16.6	9.3	24.2	6.6	18.3	0	20.4	5.2
Visual disturbances	16.3	12.5	14.7	12.5	26.6	26.3	36.8	17.6
Hearing disturbances	9.4	5.1	15.4	0	29.8	21.7	43.8	31.5
Dizziness	6.2	5.2	3.2	6.6	15.4	4.5	39.3*	9.5
Movement difficulties	0	2.3	0	0	3.5	4	21.4	10.5
Cardiovascular problems	0	2.3	5.1	0	19.2*	0	36.4	15

for 16 Non Specific Health Symptoms experienced by 530 people (270 men + 260 women) in relation to their distances from cellular phone base stations (≤300 m vs. >300 m [reference group]).

* = $P < 0.05$ for levels of complaints 2+3 pooled.

Influence of Sex and Age

Sex

In terms of the different distance zones, two complaints were experienced significantly more often for women ($P < 0.05$): nausea in the zone of less than 10 m, headaches in the zones of 10–50 m, 50–100 m, 100–200 m, and 200–300 m. Men complain significantly more often ($P < 0.05$) than women about lowering of libido in the zone of 50 to 100 m from cellular phone base stations.

When the men/women comparison is made for all subjects exposed at a distance up to 300 m, seven symptoms (i.e., headaches, nausea, loss of appetite, sleep disturbances, depressive tendencies, feeling of discomfort, and visual disturbances) are experienced significantly more often in women ($P < 0.05$) (Table 2). On the contrary, for the subjects of the reference group, there appears to be no significant difference related to sex in the frequency of complaints reported for the different symptoms.

Age

Significant differences are observed in relation to the age of the subjects (from 21 to >60 years) for symptoms such as fatigue, irritability, headaches, sleep disturbances, feeling of discomfort, dizziness, cardiovascular problems when comparisons are made between subjects living up to 300 m vs. subjects of the reference group. For subjects younger than 20 years of age, there is no significant difference in the frequency of symptoms between subjects living at up to 300 m vs. subjects of the reference group (Table 3).

DISCUSSION

This study gives evidence of the fact that NSHS are reported by people at distances up to 200 m to 300 m from cellular phone base stations. The significant increase in the frequency of complaints in relation to the reference group (people exposed at >300 m or not exposed) goes in the direction of the observation found in an Australian governmental report, which had signaled that at 200 m from a base station, some people exposed in their homes are complaining of chronic fatigue and sleep disturbances (Australian Report, 1996). Our results agree with those of a Spanish preliminary study on people living in the vicinity of cellular phone base stations, where symptoms as irritability, headaches, nausea, and sleep disturbances are experienced in a significantly higher way by the subjects located at a distance up to 150 m vs. subjects at a distance >250 m (Gomez-Perretta Cl, personnal communication, 2002).

The number of reported symptoms is higher close to base stations, and that number decreases with increased distance from them, in relation to the fact that some symptoms such as nausea, loss of appetite, visual disturbances, and difficulties in movement are no longer experienced in a significant way beyond 10 m.

Symptoms such as fatigue, headaches, and sleep disturbances, which are experienced significantly at considerable distances from base stations, exhibit no notable diminishment in the percentages of complaints experienced with increased distance. But the measurements of electromagnetic fields in the neighborhood of cellular phone base stations show a reduction in strength over distance (Petersen and Testagrosa, 1992; Santini, 1999). One could expect that human sensitivity to electromagnetic waves is such that increased distance from cellular phone base stations has no significant effect on certain NSHS symptoms up to a distance of 200 to 300 m (difference in receptors sensibility to microwaves?). It is also possible that the measurements of electromagnetic fields found around base stations may not be the true representation of populations exposure. In fact, different parameters are likely to interfere to modify the measurements and in particular fluctuations in emission strengths relating to the number of calls handled by base stations, the reflection of electromagnetic waves, etc. (Santini et al., 2000).

No significant decrease was observed in the frequency of symptoms in relation to the length of time living in the neighborhood of base stations (from <1 year to >5 years). This result shows that there is no acclimation of subjects to microwave bioeffects with duration of exposure.

This study shows that for some distances and for some symptoms, the facing location is the worst position, especially for distances of <100 m from cellular phone base stations. This result can be related to the fact that antennas emit microwave at a higher level in front than in other directions (Petersen and Testagrosa, 1992).

The results obtained demonstrate the greater sensitivity of women for 7 of the studied NSHS. One earlier study related to cellular phones users demonstrated an increase in women's sensitivity for the symptom of sleep disturbances (Santini et al., 2002). This sex-related difference is parallel to the particular sensitivity of women to electromagnetic fields (Loomis et al., 1994; Santini, 1998). The results obtained in this study also show the existence of a greater sensibility for some NSHS symptoms, in relation to age, in subjects older than 20 years. This sensibility is particularly high in subjects older than 60 years. This last results agrees with the greater sensibility of the elderly to radiofrequencies (Tell and Harem, 1979).

CONCLUSION

From these results and in applying the precautionary principle, it is advisable that cellular phone base stations should not be sited closer than 300 m to populations and most significantly because exposed people can have different sensitivities related particularly to their sex and their age. The facing position appears to be the worst one for distances from cellular phone base stations <100 m.

ACKNOWLEDGMENTS

The authors gratefully acknowledge Janet Newton, President of the EMRNetwork, for her help in editing this article. The authors also thank the participants in the study.

REFERENCES

Australian Report. (1996). A local government and community resource document: mobile phone and their transmitter base stations—the evidence for health hazards. *EmFacts Inf. Serv.* 240 pp.

Bielski, J. (1994). Bioelectrical brain activity in workers exposed to electromagnetic fields. *Ann. N.Y. Acad. Sci.* 724:435–437.

Dabis, F., Drucker, J., Moren, A. (1992). Epidémiologie d'intervention. *Editions Arnette* 589 pp.

Johson Liakouris, A. G. (1998). Radiofrequency (RF) sickness in the Lilienfeld study: an effect of modulated microwaves? *Arch. Environ. Health* 53:236–238.

Linde, T., Mild, K. H. (1997). Measurement of low frequency magnetic fields from digital cellular telephones. *Bioelectromagnetics* 18:184–186.

Loomis, D. P., Savitz, D. A., Ananth, C. V. (1994). Breast cancer mortality among female electrical workers in the United States. *J. Natl. Cancer Inst.* 86:921–925.

Mild, K. H., Oftedal, G., Sandströms, M., Wilen, J., Tynes, T., Haugsdal, B. (1998). Comparison of symptoms experienced by users of analogue and digital mobile phones. *Arbetslisrapp.* 23:1–47.

Petersen, R. C., Testagrosa, P. A. (1992). Radiofrequency electromagnetic fields associated with cellular radio cell-site antennas. *Bioelectromagnetics* 13:527–542.

Santini, R. (1998). Breast cancer in women, high voltage power lines and melatonin. *Bioelectromagn. Newsl.* 144:5.

Santini, R. (1999). Cellular telephones and their relay stations: a health risk? *La Presse Médicale* 28:1884–1886.

Santini, R., Seigne, M., Bonhomme-Faivre, L. (2000). Danger of cellular phones and their base stations. *Pathol. Biol.* 48:525–528.

Santini, R., Seigne, M., Bonhomme-Faivre, L., Bouffet, S., Defrasme, E., Sage, M. (2002). Symptoms experienced by users of digital cellular phones: a study of a French engineering school. *Electromagn. Biol. Med.* 21:81–88.

Tell, R. A., Harem, F. (1979). A review of selected biological effects and dosimetric data useful for development of radiofrequency standards for human exposure. *J. Microw. Power* 14:405–424.

Useful TETRA links: Europe

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Open letter to Edmund Stoiber, president of the federal state of Bavaria, Germany

Dr Edmund Stoiber
State Chancelry
PO Box 220011
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Urgent suspicions of serious health damage from pulsed high frequency electromagnetic fields (mobile phone base stations, DECT phones, W-LAN, Bluetooth etc.) at levels below exposure guidelines.

Dear Prime Minister,

Allow me to represent many doctors personally to you.

For eight months doctors in Oberfranken and another places have been making extremely worrying observations of patients, who live in the vicinity of mobile phone base stations. After initial suspicions at locations in Forchheim, Hirschaid, Walsdorf, Memmelsdorf and Bamberg survey measurements were made of 356 such residents in 40 locations, all in Oberfranken. Meanwhile 64 Hofer doctors, 30 Lichtenfelser, 61 Coburger, 20 from Bayreuth and countrywide, added their names to the Bamberger appeal.

The result all these medical findings is as follows.

Many people have become ill with a characteristic combination of symptoms, which is new to us as doctors, at exposure levels far below the guideline limits, which apply only to thermal effects. Residents in the vicinity of masts have one or more of the following symptoms:

Sleep disturbance, tiredness, headache, restlessness, lethargy, irritability, inability to concentrate, forgetfulness, trouble finding words, depressive tendency, noises in the ears, impaired hearing, dizziness, nosebleeds, visual disturbances, frequent infections, sinusitis, joint and muscle pains, feeling deaf, palpitations, increased blood pressure, hormone disturbances, gaining weight, hair loss, nocturnal sweating, nausea.

The following statements strengthened our suspicions:

- Frequently, many residents become sick with these symptoms at the same time, when living near a base station (e.g. Schweinfurt: Eselshöhe, in Kulmbach: Senioren-Wohnanlage Mainpark, in Hof: Kösselnestraße, in Forchheim: Ortsteil Burk).
- Many patients have reported rapid recovery when removed from exposure (by temporary relocation, removal of the source, screening, disconnection).
- After relocation, doctors have proven during re-examination of the patients, among other things, that blood pressure, heart rhythm, hormone disturbances, visual disturbances, neurological symptoms, and blood profile have returned to normal.
- Many doctors' families have in the course of the last months removed their DECT phones and were thereafter free among other things from headache, concentration disturbances, dizziness, restlessness, tinnitus, and sleep disturbance.

We therefore requested the responsible authorities (Federal Office for Radiation Protection, Federal Ministry for the Environment, Conservation and Nuclear Safety, members of the Radiation Protection Commission and the WHO) to organise local health surveys. Despite the serious, medical concern, all the authorities have refused to investigate the (to some degree) intolerable living conditions of those living locally.

Not one official health survey has been made at any base station in Germany! The SSK and the BfS have thus no level of knowledge concerning the long-term effects on resident living in the vicinity. From a medical viewpoint is this unacceptable.

I therefore turn to you to request your assistance for our patients who have no other recourse. We doctors from Oberfranken are ready to help. We urge you to immediately arrange local health surveys among people in the vicinity of base stations, at locations in Bavaria. Our concern is not that there are 'unfortunate individual cases', but that there is a medical disaster spreading to all parts of the population! To investigate our concerns, it must also be possible to switch transmitters off. From a medical viewpoint, we are seeing an emergency situation, which requires rapid action by all political means.

I implore you to take action to avoid health damage among many children, young people and adults.

Faithfully

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Taken from the following source: **http://www.powerwatch.org.uk/news/20050722_bamberg.asp**

News :: 22/07/2005 - German Doctors unite on RF health effects from masts

Send Powerwatch Feedback

Summary:

A number of German doctors are combining together to put forward their observations of adverse health effects from pulsed high-frequency EMFs (microwave) to the Prime Minister of Bavaria, Dr. Edmund Stoiber. The health effects include headaches, tiredness, inability to concentrate and dizziness, and show an alarming trend.

The following is a foreword written by the doctor who is representing the group, **Dr. Cornelia Waldmann Selsam**:

- Open letter to Edmund Stoiber, Prime Minister of Bavaria in Germany

These reports show that the people for years have been ill due to pulsed high frequency electromagnetic fields, without the treating doctors recognising the cause. For that reason, people who are receiving the high frequency at home or at work have suffered and are suffering and they receive no therapy. The deciding [effective] therapy is to end the exposure.

The continually repeated assertion in the media by the Radiological Protection Commission (Strahlenschutzkommission), that there is no proof for health risks under the present valid limits, has had the consequence that most doctors, (including myself until a year ago) have not drawn a relationship between the many unexplained illness patterns and high frequency radiation. The doctors do not know that at not one single mobile phone base station have investigations into the health-state of the people been carried out. Thus, the evaluation of the Strahlenschutzkommission in 2001 has no scientific basis.

In Oberfranken, we have just evaluated the medical complaints of 356 people who have had long-term [radiation] exposure in their homes.

- The pulsed high frequency electro magnetic fields (from mobile phone base stations, from cable-less DECT telephones, amongst others), led to a new, previously unknown pattern of illnesses with a characteristic symptom complex.
- People suffer from one, several or many of the following symptoms: Sleep disturbances, tiredness, disturbance in concentration, forgetfulness, problem with finding words, depressive mood, ear noises, sudden loss of hearing, hearing loss, giddiness, nose bleeds, visual disturbances, frequent infections, sinusitis, joint and limb pains, nerve and soft tissue pains, feeling of numbness, heart rhythm disturbances, increased blood pressure episodes, hormonal disturbances, night-time sweats, nausea.
- Even at **10μW/m²** (only 0.06 V/m average) many people are becoming ill.
- The symptoms occur in temporal and spatial relationship to exposure. It is no way only a subjective sensitivity disturbance. Disturbances of rhythm, hearing problems, sudden deafness, hearing loss, loss of vision, increased blood pressure, hormonal disturbances, concentration

impairments, and others can be proved using scientific objective measures.

- Some of the health disturbance disappears immediately the exposure ceases (removal of DECT telephone, temporary moving away from home, permanently moving away, using shielding).

Therefore, the expansion must be stopped immediately. Mobile phone base stations, in whose fields people are exposed to more than 10µW/m^2 must be turned off.

DECT telephones must be changed.

Affected people, relatives and doctors must jointly commit themselves and work together with all their energy [to this end].

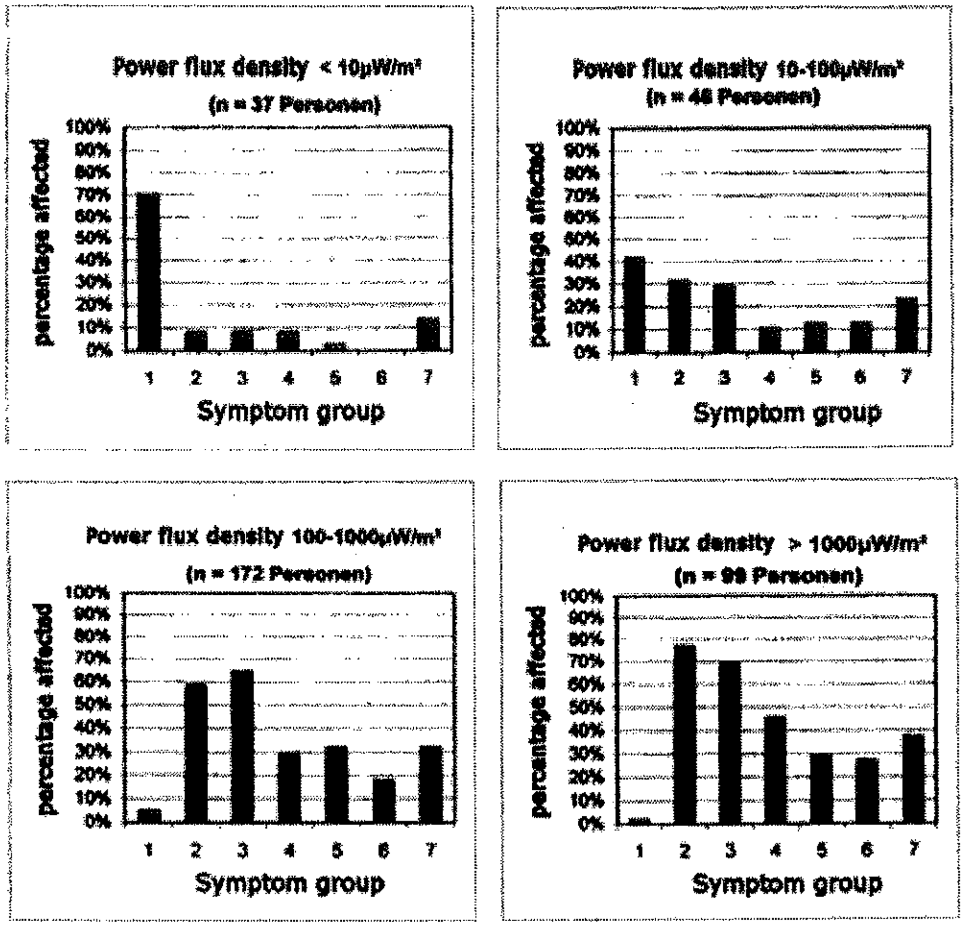
Evaluation of symptoms of 356 people under long time home exposure to high frequency pulsed electromagnetic fields (DECT,telephones, mobile phone base stations) versus the level of the power flux density in microwatts per square metre.

Foreword - Documented Health Damage under the Influence of High Frequency Electromagnetic Fields
Dr. Cornelia Waldmann Selsam, Karl-May-Str.48, 96049 Bamberg

The results of the evaluations are as follows: (* See below the graph for the definitions of the 'Symptom Groups")

It is worth explaining the indicated levels. The values convert approximately as follows:

- 10 µW/m^2 = 0.06 V/m average
- 100 µW/m^2 = 0.2 V/m average
- 1000 µW/m^2 = 0.6 V/m average



* **The symptom groups are defined as follows:**

Group 1: No symptoms

Group 2: Sleep disturbance, tiredness, depressive mood

Group 3: Headaches, restlessness, dazed state, irritability, disturbance of concentration, forgetfulness, learning difficulties, difficulty finding words.

Group 4: Frequent infections, sinusitis, lymph node swellings, joint and limb pains, nerve and soft tissue pains, numbness or tingling, allergies

Group 5: Tinnitus, hearing loss, sudden hearing loss, giddiness, impaired balance, visual disturbances, eye inflammation, dry eyes

Group 6: Tachycardia, episodic hypertension, collapse

Group 7: Other symptoms (Hormonal disturbances, thyroid disease, night sweats, frequent urge to urinate, weight increase, nausea, loss of appetite, nose bleeds, skin complaints, tumours, diabetes)

If true, this is a very clear trend. For those where it is under 10 µW/m² 70% of the sample (37 people) suffered no adverse health effects. For those where the power flux density is over 100 µW/m² only 5-6% of the sample (172 people) did not experience adverse health effects. **Please look at this graph to see how these levels translate to exposure from a typical mast. Microwave signals are often above 0.6 V/m within 400 metres!** There are no counfounding factors listed in the data, but the strength of the trend is extremely pronounced.

This is further evidence to support the potential adverse health effects that may be synonymous with the pulsed Microwave technology that surround us in everyday life. Those in the medical profession are beginning to voice their concerns, and it is worth bearing in mind that they have first hand experience of real people with real problems. It is important not to discard this evidence due to lack of experimental control, as it seems that a number of qualified professionals have independently found the same trends. At the very least this should call for more organised research into these findings.

EXHIBIT
IV37
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TNO-report

FEL-03-C148

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Effects of Global Communication system radio-frequency fields on Well Being and Cognitive Functions of human subjects with and without subjective complaints.

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Classification date	-
Title	Ongerubriceerd
Managementuittreksel	Ongerubriceerd
Abstract	Ongerubriceerd
Report text	Ongerubriceerd
Appendices	Ongerubriceerd
Contract no	-
Sponsor	Ministry of Economic Affairs, the Ministry of Spatial Planning, Housing and the Environment and the Ministry of Health, Welfare and Sport.
Affiliation	-
Project name	COFAM
Project number	015.31904
Copy no	
No of copies	200
No of pages	86 (incl. appendices, excl. RDP & distribution list)
No of appendices	6

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Netherlands Organisation for Applied Scientific Research (TNO)

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Effects of Global Communication system radio-frequency fields on Well Being and Cognitive Functions of human subjects with and without subjective complaints.

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Ongerubriceerd

Probleemstelling
Ondanks eerder wetenschappelijk onderzoek naar de relatie tussen elektromagnetische velden en klachten van mensen, is het trekken van duidelijke wetenschappelijk verantwoorde conclusies daarover moeilijk. Het in de wetenschappelijke literatuur gepubliceerde onderzoek richt zich sterk op de mogelijke effecten die gebruikers van mobiele telefoons kunnen ondervinden of toeschrijven aan radiofrequente (GSM) velden. Het Tweede-Kamerlid Wagenaar diende bij het overleg over de nota Nationaal Antennebeleid een motie in (Tweede Kamer, 2000-2001, 27 561, nr. 10) waarin de regering verzocht werd "initiatieven te nemen om tot onafhankelijk wetenschappelijk epidemiologisch onderzoek te komen naar de effecten van straling door antennes op de langere termijn en onderzoek te laten verrichten naar geuite klachten". Daarmee werd specifiek aandacht gevraagd voor klachten die mensen toeschrijven aan de aanwezigheid van GSM basisstations. Dit onderzoek kan gezien worden als een eerste antwoord op die motie en heeft dan ook de onderzoeksvraag meegekregen om de subjectieve klachten die werden toegeschreven aan GSM basisstations nader te onderzoeken.
Het onderzoek is verricht door TNO Fysisch en Elektronisch Laboratorium (TNO-FEL) in samenwerking met het onderzoeksbureau Clinical Research Facilities International (CRF-I) in Schaijk en TNO Technische Menskunde (TNO-TM) te Soesterberg. TNO heeft voor dit onderzoek opdracht gekregen van het directoraat-generaal Telecommunicatie en Post DGTP van het Ministerie van Economische Zaken (voorheen van het Ministerie van Verkeer en Waterstaat), het Ministerie van Volksgezondheid, Welzijn en Sport en het Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer. Het ministerie van Economische Zaken coördineerde namens de opdrachtgevende Ministeries. Het onderzoek is uitgevoerd op basis van een vooraf door de Medisch Ethische Toetsingscommissie (METC) goedgekeurd onderzoeksprotocol.

Beschrijving van de werkzaamheden
Dit onderzoek is uitgevoerd met twee groepen van elk 36 proefpersonen groot. Eén groep bestond uit mensen die zich in het verleden hebben aangemeld bij het Meldpuntennetwerk Gezondheid en Milieu. Zij schrijven de door hen ervaren klachten toe aan de aanwezigheid van GSM basisstations. Deze groep noemen we in dit rapport groep A. De andere groep was onze referentiegroep bestaande uit mensen zonder aangegeven hinder van deze GSM basisstations. De referentiegroep is gerekruteerd door middel van advertenties in kranten, via aankondigingen op het Internet en mond op mond reclame. De referentiegroep noemen we in dit rapport groep B.
In het onderzoek is getracht een relatie te vinden tussen blootstelling aan elektromagnetische velden afkomstig van een antenne voor mobiele telefonie en (meetbare) effecten bij mensen. De hypothese was dat er geen relatie gevonden zou worden. Tijdens het onderzoek zijn het ervaren welzijn van de mensen en de cognitieve prestaties gemeten. Het onderzoek is uitgevoerd met behulp van verschillende vragenlijsten en een, door TNO-TM vastgestelde en standaard toegepaste, set van cognitieve testen in een speciale daarvoor ingerichte onderzoeksruimte bij TNO-FEL. Deze ruimte was afgeschermd van de buitenwereld voor wat betreft de radiofrequente velden. Daardoor wisten de onderzoekers precies aan welk veld en niveau de proefpersonen werden blootgesteld.

Effects of Global Communication system radio-frequency fields on Well Being and Cognitive Functions of human subjects with and without subjective complaints.

[redacted]

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Resultaten en conclusies
Het resultaat van het onderzoek is dat er een statistisch significante relatie gevonden is tussen de aanwezigheid van radiofrequente velden die lijken op die van een UMTS basisstationsignaal en het ervaren welzijn van de proefpersonen. Deze statistisch significante relatie is voor zowel groep A als voor groep B gevonden. Met betrekking tot de cognitieve prestaties vinden we, net als in de literatuur, statistisch significante relaties die veelal een verbetering van de cognitieve prestaties inhouden. Afhankelijk van de cognitieve taak vinden we voor GSM900, GSM1800 en UMTS voor zowel groep A als groep B statistisch significante relaties tussen de uitgevoerde taak en het wel of niet aanwezig zijn van het elektromagnetische veld. Een eenduidige conclusie over de oorzaken en het biologisch mechanisme hierachter is op basis van deze resultaten niet te geven. In de internationale wetenschappelijke literatuur zijn dergelijke statistisch significante relaties in de cognitieve prestaties ook beschreven. In deze onderzoeken heeft de blootstelling echter steeds plaatsgevonden met de relatief hoge veldsterkten van mobiele telefoons bij het hoofd. Locale thermische effecten zijn in deze onderzoeken als mogelijke oorzaak gesuggereerd. Het TNO-onderzoek is uitgevoerd met lage veldsterkten, vergelijkbaar met die afkomstig van een basisstation waaraan men in de dagelijkse praktijk maximaal kan zijn blootgesteld. Computerberekeningen tonen aan dat het onwaarschijnlijk is dat de in dit onderzoek gevonden statistisch significante effecten van thermische oorsprong zijn.

Aanbeveling
Zonder twijfel zijn de resultaten van dien aard dat nader wetenschappelijk onderzoek gerechtvaardigd en noodzakelijk is. Het door ons uitgevoerde onderzoek dient gerepliceerd te worden door een van TNO onafhankelijke onderzoeksgroep. Dit is noodzakelijk om de gevonden effecten te bevestigen. Verder zal nader wetenschappelijk onderzoek moeten worden uitgevoerd of er een relatie bestaat tussen veldsterkteniveau, gebruikte frequentie en pulsvormen maar ook of er verschillen te vinden zijn tussen mannen en vrouwen en tussen volwassenen en kinderen.
De definitie van gezondheid van de Wereldgezondheidsorganisatie luidt: "a state of complete physical, mental and social well being and not merely the absence of disease or infirmity". Binnen deze definitie van de WHO is het ervaren welzijn onderdeel van de gezondheid. Het is daarom van groot belang aandacht te schenken aan de vraagstelling of er daadwerkelijk, en zo ja in welke mate, er een (blijvend) effect op de gezondheid bestaat. Belangrijk is onderzoek te verrichten naar de mogelijke biologisch mechanismen die verantwoordelijk zijn voor de gevonden effecten.

Contents

Abbreviations

AE	Adverse Event
ANOVA	Analysis of Variance
CDR	Cognitive Drug Research
CDROM	Compact Disc Read Only Memory
CRF	Case Report Form
CRF-I	Clinical Research Facilities International B.V.
DNA	Deoxyribo Nucleic Acid
EM	Electromagnetic
FDA	Food and Drug Administration
GCP	Good Clinical Practice
GSM	Global System for Mobile Communication
Hz	Hertz, unit of frequency
IARC	International Agency on Research on Cancer
ICH	International Conference on Harmonization
ICNIRP	International Commission on Non-Ionizing Radiation Protection
(k)g	(kilo)gram, unit of mass
METC	Dutch acronym, translated into Medical Ethical Review Committee
Neo FFI	Neo (New) Five-Factor InventoryQAQuality Assurance
QOL	Quality Of Life
SAE	Serious Adverse Event
SAR	Specific Absorption Rate
Sec	Second, unit of time
SAS	Statistical Analysis System
Std	Standard Deviation
SEM	Standard Error of the Mean
TNO	Netherlands Organisation for Applied Scientific Research
TNO-FEL	TNO Physics and Electronics Laboratory
UMTS	Universal Mobile Telecommunications System
V/m	Volts per meter, unit of electric field strength
W	Watt, unit of power
WHO	World Health Organization

1. Introduction

Worldwide, the introduction of the Global System for Mobile Communication (GSM) in the 1990's has dramatically increased the use of cellular telephones. Full-wave electromagnetic and thermal numerical models give insight into the thermal effects related to exposure to electromagnetic fields. However, very little information is available on the non-thermal influence of the electromagnetic fields caused by these telephones on human tissues and more specifically on brain tissues. Regularly reports on health effects associated with the use of mobile telephone systems are published in scientific magazines and usually taken over by the lay press. In virtually all cases the reports relate to experiments that are either studies in animals or short-term studies in human subjects. The investigated items are the incidence of brain tumors [1,2,3], influence on Electroencephalogram [4,5], excretion of pituitary hormones [6], cognitive functions [7-18], thermal changes in the brain [19-21], DNA damage [22], lymphocyte and mitogen stimulation [23], visual functions [24] etc.

The existing scientific evidence does not support the hypothesis that a relation exists between the incidence of brain tumors and the use of GSM-telephones. An extensive international epidemiological study is presently ongoing under the coordination of the International Agency on Research on Cancer (IARC). In this study the relationship between the use of a GSM-telephone and the incidence of tumors in the head and neck region is being investigated. Initial results will probably not be available until 2004.

Many studies with contradictory results on the influence of cellular phones have been published. Concerning the cognitive functions we have found five publications [7,8,9,12,13] that report on short-term effects on cognitive functions. Recently, Cook *et.al.* [25] published an overview. A slightly significant increase in reaction time was found by Preece *et.al.* [7] but was not supported by results obtained by Koivisto *et.al.* [8]. Krause *et.al.* [9] reported a slight increase for some memory tasks in humans exposed to a GSM-like signal. All above mentioned studies concern the acute effect on the items studied in either healthy subjects or in animals which were exposed to GSM-like signals.
Concerning hypersensitivity symptoms we have found two papers [16,18] that report a relation between subjective symptoms and RF-fields and two papers [10,17] that report no statistically significant relations.
Hietanen *et.al.* [10] studied the hypothesis that there are hypersensitive persons who perceive subjective complaints attributed to electromagnetic fields emitted by hand held mobile telephones. Double blind provocation experiments were used. From their research, they concluded that no causal link was found between exposure to cellular telephones and hypersensitivity complaints.

The present study contributes to the research on finding a relation between electromagnetic fields and brain functions. In contrast to Hietanen *et.al.* [10]

- We focused our research on people living close to base station antennas.
- We measured the cognitive functions of the subjects during the exposure (including placebo).
- We measured the Well Being by using a questionnaire.
- We performed our measurements under controlled electromagnetic conditions inside a shielded semi-anechoic chamber.
- We did not measure the physical parameters Blood Pressure and Heart Rate.

In this kind of studies, assuring reproducibility in dosimetry and electromagnetic environment is a very important issue to guarantee.

1.1 Scientific goal

The goal of this research was to determine whether a relation exists between electromagnetic fields and the subjective complaints together with cognitive performance associated with an electromagnetic stimulus. Note that only effects present during and shortly after exposure to electromagnetic fields have been studied. In addition, we examined whether thermal effects can be responsible for possible effects found in this study.

This research goal was pursued by using a double blind crossover design in order to investigate the real influence of fields on the complaints reported. Comparing the complaints as reported by the subjects with and without the presence of GSM and UMTS-like fields, and without their knowledge of that exposure condition, eliminates subjectivity. At the same time cognitive functions have been evaluated.

The objectives of the study were:

- To investigate under double-blind conditions whether or not certain complaints were reported more frequently with exposure to GSM and UMTS-like fields than in periods without GSM and UMTS-like fields, without revealing to the subject the exposure conditions at that moment.
- To investigate under double blind conditions the influence on cognitive functions of exposure (including Placebo) to GSM fields.
- To investigate under double-blind conditions the influence on cognitive functions of exposure (including Placebo) to UMTS-like fields.

1.1.1 Subjects

One way to study if the reported complaints are really an effect of exposure is to bring these subjects into an experimental setting in which they randomly undergo a period with exposure and a period without exposure, without knowing which is which. If the complaints are an effect of the GSM and UMTS-like fields the subjects should more frequently report complaints during a period of exposure than during a period without exposure.

By choosing this experimental set-up it is assumed that, if the relationship exists, this pertains to a short-term effect. In general the complaints arise shortly after exposure to GSM fields and go away once exposure is stopped. This typical feature of the complaints reported by the study subjects supports this assumption. However, not all subjects report the same complaints and not under all exposure conditions. This makes it difficult to select an optimal experimental set-up that covers all reported complaints.

In the Netherlands, people can address complaints that they ascribe to environmental factors to the Monitoring Network for Environmental Health, a non-profit organization. Subsequently, they are entitled to register their complaints. These registered people form an interesting study population. Due to legal restrictions concerning privacy protection, the Monitoring Network for Environmental Health was asked to cooperate in this study and it has acquired half the subjects for this study from their database.

The subjects for this study are classified into two groups. Group A denotes the group of subjects that have previously reported to experience complaints and have attributed these complaints to GSM exposure, Group B denotes the reference group, namely a group of subjects without any complaints. It is noted that subjects who have an impaired health status have been excluded. Persons suffering from coronary disease and psychiatric illness have been excluded as well.

1.1.2 Experimental setup

The subjects within group B do not experience complaints at any given GSM exposure and at any instance that they are exposed. Therefore it is necessary to perform the study by means of comparing the occurrence of complaints between groups. As elucidated in Chapter 16 of our study protocol [26], we have calculated that with a total sample size of 72 subjects we obtain a power of 80% to find statistically significant results regarding reported complaints between the periods with exposure and without exposure. The proposed sample size of the experiment has been capable of statistically detecting a difference of 5% on the cognitive tests that have been used.

Every subject (from groups A and B) is requested to undergo a period with GSM and UMTS-like exposure and a period without exposure. In this way every subject will serve as his/her own control. Within the design of the study a washout period has been adhered to, in order to make sure that possible effects of the exposure are not carried over to the next exposed period.

Exposure arms that have been used in the study are

1. Placebo.
2. GSM900.
3. GSM1800.
4. UMTS-like signals.

1.1.3 Experimental design

With respect to the electromagnetic field strength used in this study, it is noted that due to the lack of scientific data a prediction of reasonable electromagnetic exposure during the experiments is not possible. Exposures presented in literature were generally in the near field, because mobile phones have been used as the source of exposure. Instead, we have chosen to generate electromagnetic field strengths that can be considered a maximum value that can be found occasionally in a general living environment. We focus on base-station exposure because that is to what the subjects of group A attribute their subjective complaints.

Currently, there is no scientific evidence that electromagnetic fields induce a cumulative effect that leads to any kind of saturation. Therefore, the authors assume the absence of cumulative effects and saturation.
The scientific community lacks data concerning the causal relationship between electromagnetic field strength (stimulus) and the symptoms subjectively attributed to the stimulus. The number of symptoms and the subject's perception is diverse.

Our test system, denoted as Taskomat, which has been used in this study, has proven to be effective in the evaluation of cognition as an exponent of brain functioning, the influence of pathological processes and the effect of drugs [27].

Finally, it is noted that the constant presence of the base-station antennas during the measurements might invite the subjects to malinger the results. If that is the case, the design of the proposed study will lead to the conclusion that no relationship between electromagnetic field and the subjective complaints from this electromagnetic stimulus are found.

2. Study design considerations

Experience with questionnaires related to quality of life has shown that the first time a subject fills in such a questionnaire, the answers are given in an exaggerated way. Even a randomization as scheduled in this study and thus creating the possibility to eliminate a sequence effect cannot prevent that the discriminative power of the comparison has been affected substantially. Therefore in the present study the subjects have been evaluated during all four sessions. During the first session the subjects filled out the questionnaire and performed the cognitive function test for training reasons only. It is stressed that during that first session none of the subjects have been exposed to electromagnetic fields. The subjects were informed on the absence of GSM and UMTS-like fields.
During the second, third and the fourth session the real comparison took place under double-blind randomized conditions. The subject information sheet states that during each session it is possible that there could be exposure to GSM and UMTS-like fields. However, it was unknown to the subject during which session(s) this took place.
To ensure reproducibility of the data, the field was generated in a controlled environment. The physical parameters of the exposure were monitored and stored during the experiments. A field strength has been used that can be considered as a maximum value to account for field strengths measured in public places which are generated by GSM base stations. For uniformity within the study, we used a similar field strength for the UMTS-like fields.
On the basis of numerous measurements we determined that the electromagnetic field strengths in houses and other freely accessible locations generally does not exceed 1 V/m. Therefore, the electromagnetic field value located at a height of 1.5 m was chosen to be 1 V/m at the location of the subjects. This value is within the pertaining exposure guidelines [28] and corresponds to less than 2.5% of the lowest reference value. The measurement setup is presented in more detail in Chapter 3.

2.1.1 Hypothesis

In this study, the following hypothesis are verified:
Null-hypothesis: There is no statistically significant difference with respect to any of the subjective complaints and the Taskomat parameters as recorded during placebo exposure, relative to standardized 900 MHz exposure, 1800 MHz GSM field exposure or 2100 UMTS-like field exposure.
Alternative hypothesis: The data analysis shows that there is a statistically significant difference between one or more subjective complaints and/or Taskomat parameters as recorded during placebo exposure, relative to standardized 900 MHz exposure, 1800 MHz exposure or 2100 UMTS-like field exposure (α=0.05, two-tailed).

PAGES 14-58 OMITTED.

Complete text of report may be accessed at: —

www.tno.nl/tno/actueel/tno nieuws/2004/onderzoek tno naar effect/tno fel report 03148 def.pdf

11.5 Discussion on hypersensitivity and Well Being

Concerning hypersensitivity symptoms, we have found two papers [16,18] that report a relation between subjective symptoms and RF-fields and two papers [10,17] that report no statistically significant relations. New in our research is that we haven't studied subjective hypersensitivity symptoms, but studied the relation between GSM and UMTS-like exposure and the well-being sumscore. From the well-being sumscores, presented in 11.3.1, it may be concluded that before entering the test procedure, a difference between both groups with respect to well-being exists.

For the UMTS-like fields we have found a statistically significant effect on the well-being sumscore for both groups. Also, it is noted that in literature research to hypersensitivity has not been conclusive [10,16,17,18]. Although hypersensitivity and Well Being are two separate parameters, we would like to discuss a recently published paper on hypersensitivity by Hietanen *et.al.* [10]. We are not convinced that the study by Hietanen *et.al.* [10] has been performed in an appropriate way. First, it is not adequately verified that the electromagnetic environment was sufficiently low. They reported that their RF-environment was lower than 2 W/m^2, which indicates that the electric field strength is less than 27 V/m. Our conclusion is that they have used an inappropriate E-field sensor to verify their electromagnetic environment for their purpose. They should have verified their electromagnetic environment at least in the mV/m range, preferably frequency dependent, by using appropriate equipment and simultaneously during the experiments. Their findings that the subjects were not able to distinguish real RF-exposure to sham exposure might be compromised because it is not clear that during sham exposure the electromagnetic environment was sufficiently low with respect to the studied exposure. If that would be the case, the RF-exposure considered as stimulus could lead to non-measurable differences in the parameters under consideration.

In our research we have a completely controlled electromagnetic environment assuring that our measurements are not influenced by unknown electromagnetic sources. Secondly, Hietanen *et.al.* [10] report that the subjects were asked to describe their experienced subjective complaints. It is our opinion that the present set up provides a better way to evaluate subjective complaints by using a questionnaire for each subject throughout the study and thus obtaining an objective measure to be analyzed statistically.

Interpretation of the results should be done very carefully. It is noted that the dimension of the changes observed in the Well Being for UMTS-like exposure, though statistically significant, is relatively small. On the other hand, factors such as carry-over between sessions and the relative short exposure that is used might limit the effects observed.

12. Conclusions and recommendations

The research is carried out according to rigorous scientific standards and exhibits no major problems with respect to methodology, sample size and analysis. This is the result of two independent specialists who have reviewed the relevant documents.

From our research it is concluded that our hypotheses to find no causal relation between the presence of RF-fields and the measured parameters is rejected. We have found a statistically significant relation between UMTS-like fields with a field strength of 1 V/m and the Well Being. Both group A and group B show similar effects in the well-being results. It is noted that the World Health Organization (WHO) the definition of health reads as "a state of complete physical, mental and social well being and not merely the absence of disease or infirmity". Within this WHO definition the perceived Well Being is part of health.

Also, a statistically significant difference is observed between the generally experienced Well Being within group A and group B. The bias introduced by the selection procedure together with the different demographical structure between both groups makes a direct comparison between group A and group B invalid.

From the cognitive tasks, it is observed that a slightly higher number of significant effects is found in group B when compared to group A. The results are unlikely to be attributed to statistical noise. From the 30 cognitive function tests, we found that eight cognitive function tests are statistically significant. Statistical noise could allow up to four false statistically significant results. Note that each exposure frequency is associated with changes in some tasks or parameters, while other frequencies are not.
In Table 12.1, statistical significancies obtained from the study are presented.

Table 12.1: Overview of Statistical Significancies.

	Group A			Group B		
	GSM900	GSM1800	UMTS-like	GSM900	GSM1800	UMTS-like
Well Being						
Sumscore	-	-	X	-	-	X
Anxiety	-	-	X	-	-	-
Somatic	-	-	X	-	-	-
Inadequacy	-	-	X	-	-	X
Cognitive Test						
Reaction time	X	-	-	-	-	X
Memory comparison	-	-	-	-	X	X
Visual Selective	-	-	X	-	-	X
Dual tasking	-	-	-	-	X	-
Filtering irrelevant information	X	-	-	-	-	-

In literature, similar results on cognition are found. From our results and the available literature, it is not possible to speculate on a scientifically justified hypothesis to explain the potential effects of RF fields on cognition. However, one aspect can be tackled. In literature, it is speculated that the effects on the cognitive parameters may be explained by an unknown mechanism induced by thermal effects. In our study, it is shown that the thermal effects are negligible and therefore, an explanation based on thermal effects seems highly unlikely for effects on the cognitive parameters.

An important scientific issue is the fact that relations that are found must be reproducible. Since this research is the first one to find a statistically significant relation on Well Being by using a subset of Bulpitt's questionnaire, reproduction of our research by a research group independent of TNO is necessary.

Without any question, the results justify more scientific research into this area. Apart from the reproduction as mentioned above, research is recommended in the following area's:

- Examine a dose-response relation, decrease and increase the radio frequency field strength in order to find the effects on the dimensions found in the Well Being.
- Examine whether a difference exists between sex and adult versus children.

- Examine the biological mechanism to better understand whether the effects found can be ascribed to physical quantities and to better understand the impact to health related questions.
- Examine the biological mechanism within the brain functions to understand the potential effects on cognitive tasks.
- Examine the effect of different pulse forms and frequencies used.
- Examine why some cognitive function tests exhbit response to an RF stimulus while other cognitive function tests do not.
- Examine if the effects found for the UMTS-like signal also holds for other CDMA signals.

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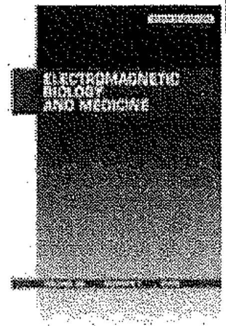

ELECTROMAGNETIC BIOLOGY AND MEDICINE
(FORMERLY ELECTRO- AND MAGNETOBIOLOGY)
VOLUME 22, ISSUE 2, (2003)

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JOURNAL 2003
SOFT COVER | ILLUSTRATED
VOLUME: 22 | PRINT ISSUES: 3
PRINT ISSN: 1536-8378
ONLINE ISSN: 1536-8386

DESCRIPTION UNIQUELY COVERING A NEW, INCREASINGLY IMPORTANT FIELD, THE RELATIONSHIP BETWEEN ELECTROMAGNETIC (NONIONIZING) RADIATION AND LIFE, *ELECTROMAGNETIC BIOLOGY AND MEDICINE* EXAMINES QUESTIONS CONCERNING THE ROLE OF INTRINSIC ELECTROMAGNETISM IN THE REGULATION OF LIVING SYSTEMS—HOW IT WORKS, WHAT IT DOES, AND HOW IT MIGHT BE HARNESSED, PARTICULARLY FOR MEDICAL USE. IT ALSO DISCUSSES THE WIDE VARIETY OF EXTRINSIC RADIATION WITH WHICH EVERYONE LIVING IN THE DEVELOPED NATIONS IS INUNDATED.

http://www.dekker.com/servlet/product/DOI/101081JBC120024625

The Microwave Syndrome: A Preliminary Study in Spain

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Journal Article | Print Published: 10/01/2003 | Online Published: 09/08/2003
Pages: 161 - 169 | PDF File Size: 297 KB
DOI: 10.1081/JBC-120024625

Online Article World Price: $18.00

The Microwave Syndrome: A Preliminary Study in Spain

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Electromagnetic Biology and Medicine
(formerly Electro- and Magnetobiology)
Volume 22, Issue 2, (2003):161-169

Online Published: 09/08/2003 September
Print Published: 10/01/2003 October

Abstract
A health survey was carried out in Murcia, Spain, in the vicinity of a Cellular Phone Base Station working in DCS-1800 MHz. This survey contained health items related to "microwave sickness" or "RF syndrome." The microwave power density was measured at the respondents' homes. Statistical analysis showed significant correlation between the declared severity of the symptoms and the measured power density. The separation of respondents into two different exposure groups also showed an increase of the declared severity in the group with the higher exposure.

Keywords
Public health, Cellular phone, Base stations, Microwave sickness

Introduction
The hypothesis that radiofrequency (RF) exposure might produce health damage has been analyzed mainly from several epidemiological studies. Insomnia, cancer, leukemia in children, and brain tumors are the clinical entities more frequently described (Dolk et al., 1997; Hocking et al.,

1996; Maskarinec et al., 1994; Minder and Pfluger, 2001; Selvin et al., 1992). Moreover, the clinical consequences of being exposed to microwave radiation such as radar has been evaluated from military and occupational studies (Balode, 1996; Garaj-Vrhovac, 1999; Goldsmith, 1997; Johnson-Liakouris, 1998; Robinette et al., 1980).

A specific symptomatology, linked to radar exposure at low levels of RF, has been termed "microwave sickness" or "RF syndrome." (Johnson-Liakouris, 1998) With few exceptions, functional disturbances of the central nervous system have been typically described as a kind of radiowave sickness, neurasthenic or asthenic syndrome. Symptoms and signs include headache, fatigue, irritability, loss of appetite, sleepiness, difficulties in concentration or memory, depression, and emotional instability. This clinical syndrome is generally reversible if RF exposure is discontinued.

Another frequently described manifestation is a set of labile functional cardiovascular changes including bradycardia, arterial hypertension, or hypotension (Johnson-Liakouris, 1998). This form of neurocirculatory asthenia is also attributed to nervous system influence. More serious but less frequent neurologic or neuropsychiatric disturbances have occasionally been described as a diencephalic syndrome (Johnson-Liakouris, 1998). All these disturbances following low level exposures (of the order of microwatts/cm^2) have been reported for many years from Eastern Europe. The exposures have been mainly low level and long term (Goldsmith, 1997; Johnson-Liakouris, 1998).

Also, several articles have found biological dysfunction at very low density of radiation without temperature elevation, favoring the hypothesis of nonthermal biological effects and pointing to the probability of clinical dysfunction below the actual standard of safety norms in the European Union (Arber and Lin, 1985; Baranski, 1972; Byus et al., 1988; Daniells et al., 1998; de Pomerai et al., 2000; D'Inzeo et al., 1988; Dutta et al., 1989; Kues et al., 1992; Lai and Singh, 1995-1997; Lai et al., 1984, 1989; Malyapa et al., 1998; Sanders et al., 1985; Sarkar et al., 1994; Stagg et al., 1997; Wachtel et al., 1975).

Low levels of RF are found around the GSM-DCS cellular phone Base Stations (BS), where antennas are usually located on the roofs or in the top of tall towers. GSM-DCS cellular phones use pulsed microwaves. These signals have a spectral similarity to radar signals. The spectral power distribution of pulsed signals includes low frequency harmonics. Typical pulse duration time ranges from 100 msec to 0.050 µsec in radar, and 576.9 µsec for each slot of GSM-DCS.

From this point of view, the hypothesis of a "microwave sickness" in the neighborhood of the GSM-DCS Base Stations is analyzed in this study. The present analysis tries to evaluate if there is some statistical justification to the complaints and related dysfunction locally associated with RF exposure from the GSM-DCS Base Stations, as has been found in previous studies (Santini et al., 2001, 2002a&b).

Materials and Method

A local team, specially trained for this work, delivered the questionnaires in La Ñora, a town of Murcia in Spain during January 2001. This was always introduced to respondents as a part of a study to evaluate the impact on the area of the cellular phone Base Stations (GSM-DCS). In general, the people were quite prepared to cooperate (the ratio of returned to delivered was about 70%). The questionnaire was a Spanish language adaptation of the Santini publication (Santini et al., 2001). This was composed of 25 different items mainly concerning health information about the respondents.

The respondents scored and marked from 0 to 3 the presence of the suffered health dysfunction: 0 never, 1 sometimes, 2 often, 3 very often.

The asked symptoms were those described in earlier studies of the microwave syndrome: fatigue, irritability, headache, nausea, appetite loss, insomnia, depression, discomfort, difficulty in concentration, memory loss, skin alterations, visual dysfunction, auditory dysfunction, dizziness, gait difficulty, and cardiovascular alterations.

Questions included demographic data: address, sex, and age, distance to the antennas (distance in meters to the Base Station), exposure time in days/weeks, hours/days, and time from the beginning of the emissions. The questionnaire also collected information about proximity to power lines, and the use of personal computer and cellular phone.

More than 5% of the population of La Ñora (around 1900 habitants) answered the questionnaire. Questionnaires from people with a history of deep psychological or neurological disease were excluded. Finally, 101 surveys were considered valid.

The survey was supplemented with electric field measurements, conducted February 24, 2001, and March 10, 2001 (Saturday). Measurements were carried out from 11:00 hr to 19:00 hr each day, in the bedrooms of each respondent. More measurements were carried out in the streets during working days and weekends, to check the possible variability in time of the measurements. The measurements were individually added to the survey of each respondent.

A portable broadband (1 MHz-3 GHz) electric field meter (EFM) was used. The EFM was hand-oriented in order to measure the maximum field strength above the bed. The electric field in each room presented a standing wave pattern because of reflection of the waves from the walls and metallic structures such as windows and metallic furniture. Therefore the EFM was held around 1 m from the walls, 1.2 m above the ground, and was moved around a circle of 25 cm of radius, orienting the antenna to get the maximum electric field strength.

The EFM was calibrated in the anechoic chamber of the University of Valencia with a standard measurement set-up using a network analyzer HP-8510C.

To check the intensity of TV and radio channels, as well as the number of working channels of the GSM-DCS BS, measurements of the spectral power density were carried out with a probe antenna and a portable spectrum analyzer.

The TV and radio channels maintained their intensities during the measurements, but the cellular phone channels presented dramatic differences in amplitude from channel to channel, some of them going on and off the air at random times.

The probe was mounted on a linen phenolic tripod about 1.2 m above the ground. The location of the probe was the same on both days, on a hill next to the town, 20 m from the BS. With the spectrum analyzer we scanned the GSM and DCS bands, at the beginning of the journey, taking the average over a period of 6 min. The measurement of the spectrum was similar on both days, having a difference in the peak estimation (carriers of the channels) of about 1 dB.

Results

The respondents were 47% male and 53% female, with a wide age range: 15-25 years (22%), 26-35 years (22%), 36-45 years (19%), 46-55 years (11%), 56-65 years (13%), and over 65 years (13%).

The exposure time, explained as the time spent in the vicinity of the BS, was more than 6 hr per day, 7 days a week, for 95% of the respondents. The bedroom was where the electric field was measured.

Concerning the attitude of the respondents about the use of cellular phone: 24% of them declared themselves to be active users of mobile GSM-DCS phone for more than 20 min per day.

The measurements were very low compared with European safety guidelines 1999/519/EC DOCE 30/7/99 (1999/519/EC:). Actually the levels were lower than 0.2 μW/cm^2. The Spanish legislation established a maximum limit of 450 μW/cm^2 at a single frequency (900 MHz), the same as the European safety guidelines 1999/519/EC DOCE 30/7/99. This is one of the characteristics of the present work: the low levels of RF exposures.

We divided the surveys into two groups: One group with high exposure, averaging 0.11 μW/cm^2, consisted of 47 respondents. These respondents declared themselves to be living less than 150 m from the BS. The second group, with an average exposure of 0.01 μW/cm^2, were at a distance greater than 250 m.

Although both groups were obviously at different distances from the BS, there was still the risk of a distance perception that could influence the survey.

Table 1 shows the average declared severity in both groups.

Table 1. Average Severity of the Reported Symptoms in Two Groups Having Different Exposure: Higher Exposure with Average Power Density 0.11 μW/cm^2 (Distance < 150 mts), and Lower Exposure with Average Power Density 0.01 μW/cm^2 (Distance > 250 mts).

***P* value**

Respondents

N = 54
N = 47

Average power density μW/cm^2

0.11 ± 0.19
0.01 ± 0.04
< 0.001

Distance to BS

< 150 m
(107 ± 57 m)
> 250 m
(284 ± 24 m)
< 0.001

Average value of reported severity
Average value of reported severity

Fatigue

1.11 ± 1.13
0.74 ± 1.07
n.s.

Irritability

1.56 ± 1.08
1.04 ± 1.02
< 0.05

Headache

2.17 ± 0.86
1.53 ± 1.00
< 0.001

Nausea

0.93 ± 0.99
0.53 ± 0.88
< 0.05

Appetite loss

0.96 ± 1.03
0.55 ± 0.88
< 0.05

Discomfort

1.41 ± 1.11
0.87 ± 0.97
< 0.02

Gait difficulty

0.68 ± 0.93
0.94 ± 1.07
n.s.

<u>ASTHENIC symptoms</u>

8.81 ± 4.79
6.21 ± 5.33
< 0.02

Sleep disturbance

1.94 ± 0.92
1.28 ± 1.10
< 0.01

Depression

1.30 ± 1.19
0.74 ± 1.01
< 0.02

Difficulty in concentration

1.56 ± 1.14
1.00 ± 1.06
< 0.02

Memory loss

1.41 ± 1.05
1.04 ± 1.08
n.s.

Dizziness

	1.26 ± 1.14	
	0.74 ± 1.05	
	< 0.05	
		DIENCEPHALIC symptoms
	7.46 ± 3.90	
	4.81 ± 4.34	
	< 0.01	
Skin alterations		
	0.72 ± 0.96	
	0.45 ± 0.93	
	n.s.	
Visual dysfunction		
	1.11 ± 1.07	
	0.96 ± 1.12	
	n.s.	
Auditory dysfunction		
	1.06 ± 1.12	
	0.81 ± 1.12	
	n.s.	
		SENSORIAL symptoms
	2.89 ± 2.72	
	2.32 ± 2.45	
	n.s.	
Cardiovascular alterations		
	0.76 ± 1.10	
	0.49 ± 0.93	
	n.s.	

A possible relationship between the declared severity of the symptom and the microwave power density was explored. A mathematical model with logarithmic dependence on the measured electric field (EFM) was used. The SPSS statistical package, with different regression methods, was used for this analysis. The results for the correlation coefficient and statistical significance are presented in Table 2 . Correlation coefficients were grouped in four sections: asthenic, diencephalic, sensorial, and cardiovascular symptoms.

Table 2. Correlation Coefficient Between Severity of the Reported Symptoms and the Logarithm of the Measured Electric Field.

	Correlation coefficient with power density	*p* value
ASTHENIC symptoms		
Fatigue	0.438	< 0.001
Irritability	0.515	< 0.001
Headache	0.413	< 0.001
Nausea	0.354	< 0.001
Appetite loss	0.485	< 0.001
Discomfort	0.544	< 0.001
Gait difficulty	0.127	n.s.
DIENCEPHALIC symptoms		
Sleep disturbance	0.413	< 0.001
Depression	0.400	< 0.001
Difficulty in concentration		

	0.469	< 0.001
Memory loss	0.340	< 0.001
Dizziness	0.357	< 0.001
<u>SENSORIAL symptoms</u>		
Skin alterations	0.358	< 0.001
Visual dysfunction	0.347	< 0.001
Auditory dysfunction	0.163	n.s.
CARDIOVASCULAR symptoms		
Cardiovascular alterations	0.290	< 0.01

Second Column is the Statistical Significance (*p*) of the Correlation Coefficient.

Discussion

It is interesting to compare the severity of the reported symptoms between both groups of Table 1 : more severe symptoms were reported in the first group. The first group (< 150 m from BS) was exposed to a mean EMF power density 10 times higher than the second group (> 250 m from BS). Asthenic syndrome was 42% higher in the first group, diencephalic syndrome was 55% higher in the first group, sensorial alterations were 25% higher in the first group, and cardiovascular alterations 55% higher as well.

However, the use of mobile phones was 30% in the first group and 17% in the second group. Use of the personal computer was 16% in the first group and 1% in the second group. Therefore, these differences could bias the health response. The use of the mobile cellular phone implies a considerably higher exposure of the head to microwaves during the phone call, roughly 5 mW/cm^2, 10,000 times higher than the maximum EMF exposure attributed to the BS. Moreover, the symptomatic response could be influenced by personal or human idiosyncrasy. The exposure to radiation from the computer screen occurs at extremely low frequencies and is under 0.3 μT, at normal distances. It is therefore not considered significant, but will be the subject of a future work.

Results from Table 2 indicate the correlation between severity of the reported symptoms and the logarithm of the measured electric field (EFM) with $p < 0.001$. We find that discomfort (0.544), irritability (0.515), and appetite loss (0.485) are the most relevant symptoms correlated with exposure intensity. Others symptoms, fatigue (0.438), headache (0.413), difficulty in concentrating (0.469), and sleep disturbances (0.413), also show a significant correlation with exposure intensity. However, other symptoms such as auditory dysfunction, gait difficulty, and cardiovascular, have a lower correlation coefficient, but significant $p < 0.01$.

However, the most interesting aspect of our results is the significance of the dependence between both variables: The declared severity of the symptom and the logarithm of the measured electric field. Another interesting observation is that four of the highly correlated symptoms (Table 2) such as headache, sleep disturbances, concentration difficulty, and irritability also show the most relevant differences between both groups and the highest values in the clinical scale, 2.17, 1.94, 1.56, and 1.56 respectively (Table 1).

The validity and interpretation of the results of Tables 1 and 2 must be analyzed in the proper context, by comparison with results from other researchers, or with our results from previous similar surveys. Actually there are no studies similar to the presented in this communication. However, our work shows a similarity in procedure and results with previous surveys on noise annoyance. Results for the correlation coefficients (Table 2) are similar to those obtained in previous social surveys on noise annoyance, where the maximum correlation coefficient was around 0.35 (Schultz, 1978).

If there is a casual relationship between severity of the symptoms and the measured electric field, it may be that the logarithmic approach is still too approximate, and a more elaborate model would be convenient. The logarithmic model is extended in the analysis of noise annoyance, since the devices used in noise measurements use logarithmic scales (dB_A). Moreover, the used measurement was a spatial-point, timepoint, measurement. This would most likely be an improvement in correlation for EMF average levels during days or weeks. However, the existence of appropriate instrumentation is a limitation.

It is worth pointing out that noise is a recognized environmental pollutant, and the social surveys on noise annoyance address its subjective response. Although noise is perceived by the senses, the same is not true for the electromagnetic field. Therefore biasing is less likely in the present study, and the results are probably more objective than in the surveys on noise annoyance.

Trying to find comparisons between our results and previous work, we can claim a strong similarity with the Lilienfeld study (Johnson-Liakouris, 1998), which showed a dose-response relationship between various neurological symptoms and microwave exposure. These symptoms were grouped under the name "microwave syndrome" or "radiofrequency radiation sickness."

The present results demonstrate a significant correlation between several symptoms of what is called microwave sickness and the microwave power density associated with the Base Station located on a hill at the edge of the town. The severity of the symptoms weakens for people who live far away, at a distance greater than 250 m from the main EMF source and at a power density lower than 0.1 $\mu W/cm^2$.

As there is a significant difference between both groups in terms of the irradiated power density, a hypothetical relationship between the DCS emission and the severity of symptoms may exist.

There is a large and coherent body of evidence of biological mechanisms that support the conclusion of a plausible, logical, and causal relationship between RF exposure and neurological disease. Hence it is possible that cell sites are causing adverse health effects. Public health surveys of people living in the vicinity of cell site BSs should be carried out immediately, and continued over the next 2 decades. Prompt effects such as miscarriage, cardiac disruption, sleep disturbance, and chronic fatigue could well be early indicators of adverse health effects.

This is the first social survey concerning the microwave syndrome carried out in Spain, and is a preliminary study. Future surveys in another geographical locations are underway. More research and comparison of statistical results from different areas would be useful.

At present, the electromagnetic/microwave power density is not a recognized environmental pollutant. The reported results are obtained from one of the first social surveys on the health of the population living in the vicinity of a Base Station of GSM-DCS cellular phone.

References

Arber S. L. , Lin J. C., Microwave-induced changes in nerve cells: effects of modulation and temperature, *Bioelectromagnetics, 6* (1985) 257-270.

Balode Z., Assessment of radio-frequency electromagnetic radiation by the micronucleus test in bovine peripheral erythrocytes, *Sci. Total Environ., 180* (1996) 81-85.

Baranski S., Histological and histochemical effects of microwave irradiation on the central nervous system of rabbits and guinea pigs, *Am. J. Phys. Med., 51* (1972) 182-190.

Byus C. V. , Kartun K. , Piper S. , Adey W. R., Increased ornithine decarboxylase activity in cultured cells exposed to low energy modulated microwave fields and phorbol ester tumor promoters, *Cancer Res., 48* (1988) 4222-4226.

Daniells C. , Duce I. , Thomas D. , Sewell P. , Tattersall J. , de Pomerai D., Transgenic nematodes as biomonitors of microwave-induced stress, *Mutat. Res., 399* (1998) 55-64.

de Pomerai D. , Daniells C. , David H. , Allan J. , Duce I. , Mutwakil M. , Thomas D. , Sewell P. , Tattersall J. , Jones D. , Candido P., Non-thermal heat-shock response to microwaves, *Nature, 405* (2000) 417-418.

D'Inzeo G. , Bernardi P. , Eusebi F. , Grassi F. , Tamburello C. , Zani B. M., Microwave effects on acetylcholine-induced channels in cultured chick myotubes, *Bioelectromagnetics, 9* (1988) 363-372.

Dolk H. , Shaddick G. , Walls P. , Grundy C. , Thakrar B. , Kleinschmidt I. , Elliott P., Cancer incidence near radio and television transmitters in Great Britain. I Sutton Coldfield transmitter, *Am. J. Epidemiol., 145* (1997) 1-9.

Dutta S. K. , Ghosh B. , Blackman C. F., Radiofrequency radiation-induced calcium ion efflux enhancement from human and other neuroblastoma cells in culture, *Bioelectromagnetics, 10* (1989) 197-202.

Garaj-Vrhovac V., Micronucleus assay and lymphocyte mitotic activity in risk assessment of occupational exposure to microwave radiation, *Chemosphere, 39* (1999) 2301-2312.

Goldsmith J. R., Epidemiologic evidence relevant to radar (microwave) effects, *Environmental Health Perspectives, 105* (Suppl 6) , (1997) 1579-1587.

Hocking B. , Gordon I. R. , Grain H. L. , Hatfield G. E., Cancer incidence and mortality and proximity to TV towers, *Med. J. Aust., 165* (1996) 601-605.

Johnson-Liakouris A. J., Radiofrequency (RF) sickness in the Lilienfeld study: an effect of modulated microwaves?, *Arch. Environ. Health, 53* (1998) 236-238.

Kues H. A. , Monahan J. C. , D'Anna S. A. , McLeod D. S. , Lutty G. A. , Koslov S., Increased sensitivity of the non-human primate eye to microwave radiation following ophthalmic drug pretreatment, *Bioelectromagnetics, 13* (1992) 379-393.

Lai H. , Singh N. P., Acute low-intensity microwave exposure increases DNA single-strand breaks in rat brain cells, *Bioelectromagnetics, 16* (1995) 207-210.

Lai H. , Singh N. P., Single- and double-strand DNA breaks in rat brain cells after acute exposure to radiofrequency electromagnetic radiation, *Int. J. Radiat. Biol., 69* (1996) 513-521.

Lai H. , Singh N. P., Melatonin and a spin-trap compound block radiofrequency electromagnetic radiation-induced DNA strand breaks in rat brain cells, *Bioelectromagnetics, 18* (1997) 446-454.

Lai H. , Horita A. , Chou C. K. , Guy A. W., Effects of low-level microwave irradiation on amphetamine hyperthermia are blockable by naloxone and classically conditionable, *Psychopharmacology, 88* (1984) 354-361.

Lai H. , Carino M. A. , Guy A. W., Low-level microwave irradiation and central cholinergic systems, *Pharmacol. Biochem. Behav., 33* (1989) 131-138.

Malyapa R. S. , Ahern E. W. , Bi C. , Straube W. L. , LaRegina M. , Pickard W. F. , Roti Roti J. L., DNA damage in rat brain cells after in vivo exposure to 2450 MHz electromagnetic radiation and various methods of euthanasia, *Radiat. Res., 149* (1998) 637-645.

Maskarinec G. , Cooper J. , Swygert L., Investigation of increased incidence in childhood leukemia near radio towers in Hawaii: preliminary observations, *J. Environ. Pathol. Toxicol. Oncol., 13* (1994) 33-37.

Minder C. E. , Pfluger D. H., Leukemia, brain tumors, and exposure to extremely low frequency electromagnetic fields in Swiss railway employees, *Am. J. Epidemiol., 153* (2001) 825-835.

Robinette C. D. , Silverman C. , Jablon S., Effects upon health of occupational exposure to microwave radiation (radar), *Am. J. Epidemiol., 112* (1980) 39-53.

Sanders A. P. , Joines W. T. , Allis J. W., Effect of continuous-wave, pulsed, and sinusoidal-amplitude-modulated microwaves on brain energy metabolism, *Bioelectromagnetics, 6* (1985) 89-97.

Santini R. , Santini P. , Seigne M. , Danze J. M., Symptoms expressed by people living near cell phone relay stations, *La Presse Médicale, 30* (32) , (2001) 1594.

Santini R. , Le Ruz P. , Danze J. M. , Santini P. , Seigne M. Preliminary study on symptoms experienced by people living in vicinity of cellular phone base stations, *Bioelectromagnetics 24th Meeting. Abstract Book,* John Wiley & Sons, Inc., for the Bioelectromagnetic Society, Québec, Canada, 2002.

Santini R. , Santini P. , Danze J. M. , Le Ruz P. , Seigne M., Symptoms experienced by people in vicinity of base station : I/ Incidences of distances and sex, *Pathol. Biol., 50* (2002) 369-373.

Sarkar S. , Ali S. , Behari J., Effect of low power microwave on the mouse genome: a direct DNA analysis, *Mutat. Res., 320* (1994) 141-147.

Schultz T. J., Synthesis of social surveys on noise annoyance, *J. Acoust. Soc. Am., 64* (1978) 377-405.

Selvin S. , Schulman J. , Merrill D. W., Distance and risk measures for the analysis of spatial data: a study of childhood cancers, *Soc. Sci. Med., 34* (1992) 769-777.

Stagg R. B. , Thomas W. J. , Jones R. A. , Adey W. R., DNA synthesis and cell proliferation in C6 glioma and primary glial cells exposed to a 836.55 MHz modulated radiofrequency field, *Bioelectromagnetics, 18* (1997) 230-236.

Wachtel H. , Seaman R. , Joines W., Effects of low-intensity microwaves on isolated neurons, *Ann. N.Y. Acad. Sci., 247* (1975) 46-62.

1999/519/EC:, Council Recommendation of 12 July 1999 on the limitation of exposure of the general public to electromagnetic fields (0 Hz to 300 GHz), *Official Journal of The European Communities,* (1999) L199/59-L199/70, 30.7. (http://europa.eu.int/eur-lex/pri/en/oj/dat/1999/1 199/1 19919990730en00590070.pdf).

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EXHIBIT
IJ39

© Med Sci Monit, 2004; 10(7): CR336-340
PMID: 15232509

www.MedSciMonit.com
Clinical Research

Received: 2003.11.05
Accepted: 2004.01.07
Published: 2004.07.02

Malignant melanoma of the skin – not a sunshine story!

Authors' Contribution:
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B Data Collection
C Statistical Analysis
D Data Interpretation
E Manuscript Preparation
F Literature Search
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Summary

Background: In an earlier study on malignant melanoma incidence in Sweden, Norway, Denmark and the USA, we found a strong association between the introduction of FM radio broadcasting at full-body resonant frequencies and increasing melanoma incidence. The purpose of the current study was to review mortality and incidence data for malignant melanoma of the skin in Sweden and its temporal relation to increased "sun-traveling", and to the introduction of FM and TV broadcasting networks.

Material/Methods: Official, published information was collected and displayed graphically. These data included incidence rates of malignant melanoma, death numbers, charter travel statistics, and data on the expansion of the FM broadcasting network in all counties of Sweden.

Results: A good correlation in time was found for the rollout of FM/TV broadcasting networks while the increased amount of "sun travel" by air (charter) did not start until 7 years after the melanoma trend break in 1955. Counties that did not roll out their FM-broadcasting network until several years after 1955 continued to have a stable melanoma mortality during the intervening years.

Conclusions: The increased incidence and mortality of melanoma of skin cannot solely be explained by increased exposure to UV-radiation from the sun. We conclude that continuous disturbance of cell repair mechanisms by body-resonant electromagnetic fields seems to amplify the carcinogenic effects resulting from cell damage caused e.g. by UV-radiation.

key words: **melanoma • skin • UV • sun • radio • TV • broadcasting**

Full-text PDF: http://www.MedSciMonit.com/pub/vol_10/no_7/4321.pdf
Word count: 2482
Tables: –
Figures: 6
References: 20

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BACKGROUND

Melanoma of the skin is a deadly disease. It is currently the fastest increasing cancer in Sweden, and also in many other countries. The main reason for this increase has been attributed to the "Western lifestyle," including increased travelling and a positive attitude to sunbathing and tanned skin [1]. In 1994, a consensus conference on the subject "Preventing the development of malignant melanoma" came to the conclusion that "The UV radiation from the sun is the only assured external cause for developing malignant melanoma of skin" [2].

In 2002, the present authors [3] concluded that there is an association between melanoma incidence and exposure to FM broadcasting radiation. Since increased exposure to UV radiation from the sun is the most commonly given explanation for the increase in incidence and mortality of malignant melanoma, we decided to take a closer look at the statistics about "sun travel," i.e. charter traveling to sunbathe and swim during vacation.

MATERIAL AND METHODS

Incidence rates of malignant melanoma of the skin were collected from several countries. The number of deaths caused by malignant melanoma during the 20th century in Sweden was collected from the WHO mortality database and Swedish death statistics. We also retrieved information on the development of charter traveling from Sweden and the expansion of the Swedish FM radio broadcasting network during the same time period. Charter travel basically developed to make it possible for ordinary people to fly abroad to virtually guaranteed sun and leisure in warmer countries. By comparing these sets of data, we intended to see if they were related in time, in a logical cause-and-effect order.

We collected all information on melanoma mortality, incidence and charter travel statistics by using data bases available on the Internet. The data was then analyzed and presented in various graphs, some of which are reproduced here.

RESULTS

The incidence of malignant melanoma has increased dramatically in many countries during the last part of the 20th century. Figure 1 shows the development over time in several countries.

An even more drastic trend break can be seen in the development of melanoma mortality over time. Figure 2 shows the development of the number of persons in Sweden who died due to malignant melanoma of the skin. A drastic increase in the number of annual mortalities occurred in 1955 and continued further on. It is interesting to note that mortality shows the fastest increase in 1955, then slows down, while the incidence slowly picks up speed, reaching the fastest increase around 1980, i.e. 25 years later than the strongest acceleration in mortality. All data in this figure have been normalized to the data for 1988.

The Swedish Civil Aviation Administration (Luftfartsverket) [4] provides data that give a good measure of traveling habits in Sweden, i.e. the number of charter flights from Sweden to foreign countries over the years. Figure 2 also shows how the number of charter flights increased from 10,000 in 1955 to 1.4 million in 1988. The real start of this traffic did not take place, however, until 1962, when there were 0.1 million such flights.

FM broadcasting to the general population started in 1955, and the coverage was expanded over time, so that a major part of the country was covered during the 1970s. Figure 2 also shows the development of the total number of people who came to be exposed to electromagnetic fields with half-wavelengths of 1.5 m, or a frequency around 100 MHz.

Figure 2 shows that melanoma deaths increased sharply in 1955, while "sun travel" did not start in earnest until some 7 years later. This makes it quite unlikely that the melanoma deaths were caused by the increasing number of flights. Also, skin melanoma incidence starts a steady increase rather too early to support the hypothesis of a correlation. Thus the data do not support the "sun travel" theory.

Skin melanoma deaths increased by 22% (from 63 to 77 cases) in 1955, the same year the rollout of the FM and TV1 broadcasting networks began (see Figure 2). The death toll then increased steadily up until today.

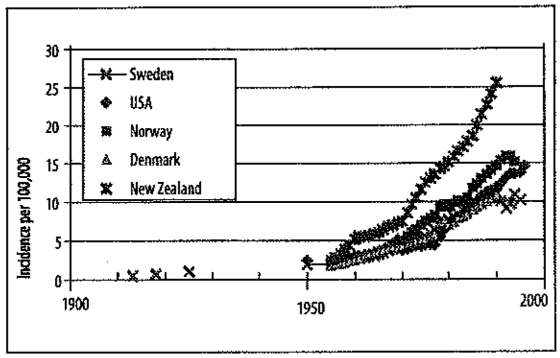

Figure 1. Melanoma incidence is accelerating in several countries.

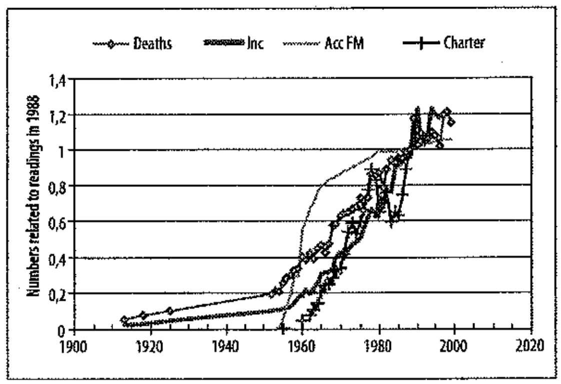

Figure 2. This graph gives the annual number of persons in Sweden who died due to melanoma of the skin, the annual number of new cases (incidence; inc), the annual number of charter flights made, and the accumulated number of persons covered by FM broadcasting; all data are normalized to the measured values from 1988.

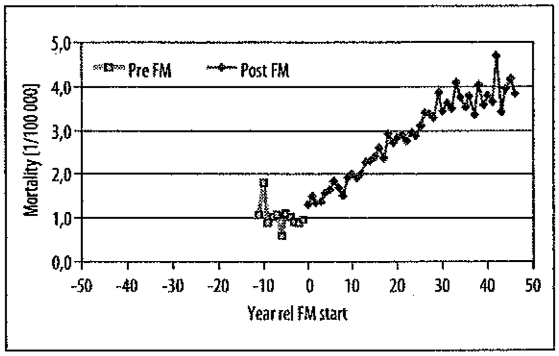

Figure 3. Mortality from malignant melanoma in the Swedish population relative to the time since or before the start of FM broadcasting in the different counties.

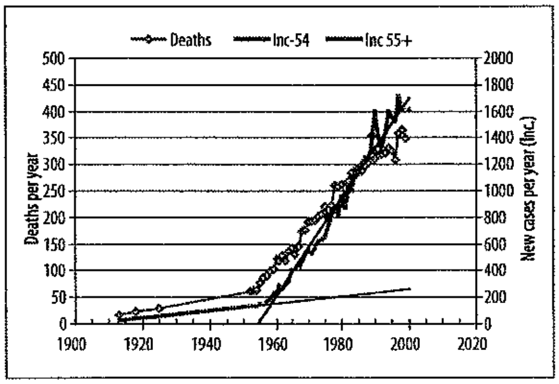

Figure 4. This plot shows that the melanoma mortality outbreak came about 5 years before an increase in melanoma incidence became obvious.

It took over 10 years to reach full coverage of FM broadcasting in Sweden. This gradual introduction could make it difficult to notice trend breaks in the health status of the population caused by exposure to the new electromagnetic environment. It was possible, however, to get information about when different counties in Sweden had their first FM transmitting towers up and running. It was also possible to calculate the mortality in each county over time, and also to plot the total mortality relative to the time before or after the introduction of FM broadcasting in each county. The results of this analysis are shown in Figure 3.

The total number of new cases and deaths per year in Sweden due to malignant melanoma is shown in Figure 4, and the increase from the data for 1954 is shown in Figure 5.

A look at international statistics on melanoma mortality reveals a common pattent: melanoma mortality starts to increase drastically in the second half of the 20th century. An example is shown in Figure 6.

DISCUSSION

Our findings may seem somewhat revolutionary to those who think that the sun is the only radiation source to be blamed for the contemporary plague of skin cancer. Here we shall first discuss our own findings, and then refer to other published work, in order to reach a better understanding of the possible mechanisms involved.

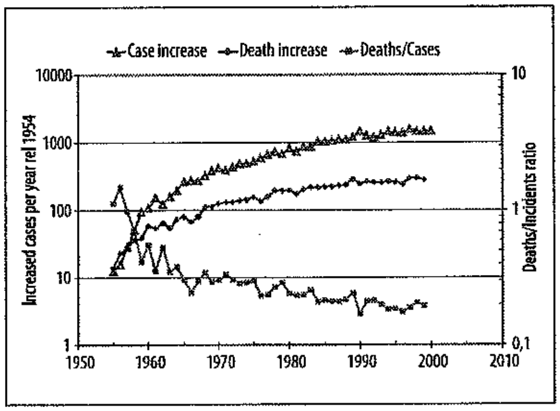

Figure 5. This plot shows the increase in annual deaths and new cases of melanoma reported in Sweden, as compared with the data from 1954. The ratio between deaths and reported new cases is added.

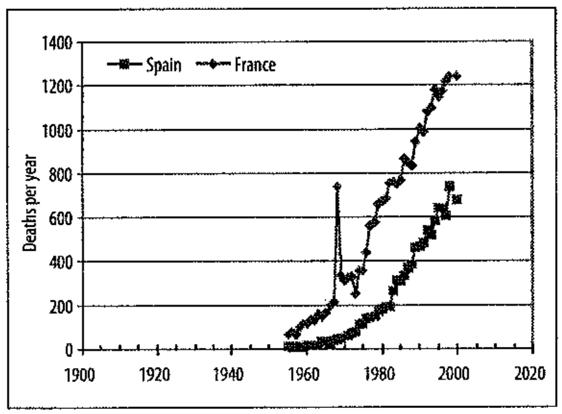

Figure 6. This plot gives the annual number of people who have died from melanoma of the skin in France and Spain since 1955.

Malignant melanoma and electromagnetic fields

There can be no doubt that a relation exists between UV radiation and melanoma of the skin. Also, there is no doubt that UV radiation is a form of electromagnetic radiation that is capable of damaging cells in different ways. The depletion of the ozone layer over the last decades has become a cause for concern regarding skin and eye melanoma. But no strong increase in UV radiation due to ozone depletion was noticed as early as 1955. Consequently, there must be something else that suddenly accelerated the transformation of damaged cells into skin cancer.

Figure 3 shows mortality due to malignant melanoma in Sweden. The left side shows mortality in all counties before the implementation of FM broadcasting. Some counties had to wait for 11 years before they could enjoy FM radio broadcasting. The right side shows mortality vs. the time since the start of FM broadcasting. It is obvious that the mortality took a sharp upward trend break, from a flat, stable level to continuously increasing numbers, beginning the same year FM broadcasting was introduced.

It has been argued [5] that mortality statistics are uncertain for several reasons, and it is recommended to use incidence data for exposure-response analysis. Our view is that a sudden change in environmental conditions might give a fast response in mortality (among all cancer patients who are still alive), while it may take several years before completely new cancer cases are caused by a new source of environmental stress. This is especially true if the environmental stress in question weakens the immune system, rather than directly causing the formation of new cancer cells.

We noticed that melanoma mortality increased suddenly from 1955 and onwards, while melanoma incidence initially increased more gradually over time, about 3 years later. This is shown in Figure 4. Normally it is expected that incidence should begin to increase first, and that mortality response would follow later on.

In Figure 5 we show the increase of annual deaths and reported new cases compared to the corresponding numbers in 1954. The death/incidence ratio exceeds 100% at the beginning, and goes down towards 20% in the year 2000. This is a clear indication that mortality among melanoma patients suddenly increased in 1955.

Our detailed study of cancer mortality in different countries shows that melanoma mortality started to increase drastically during the last part of the 20th century in many countries. Examples from France and Spain are given in Figure 6. Note that in the turbulent year of 1968 an additional 550 people died from melanoma of the skin in France. This extraordinary outbreak still lacks an explanation from the authorities.

Our hypothesis (ref. [3]) is simply that full body resonance effects, which easily occur in the 100 MHz frequency range, cause electric currents to pass through the body, sometimes for prolonged periods, e.g. during sleep at night. These currents may interfere with cell repair mechanisms that normally are supposed to clean up the body and repair damaged cells.

If such an impairment of the cell repair mechanisms was suddenly imposed on a given population, then it would be logical to expect that patients with advanced skin cancer would also show increased mortality from the same point in time. Such an increased mortality has been demonstrated not only in Sweden, as shown above, but also in Queensland [6].

There have been only a few reports on the influence of low-level radiation on skin cancer and malignant melanoma. A classic report is that of Dolk et al. [7], who found that "A significant decline in risk with distance was also found for skin cancer, possibly related to residual socio-economic confounding, as for bladder cancer." Recently, Tynes et al. [8] reported an association between calculated residential magnetic fields and cutaneous malignant melanoma: "Magnetic fields over 0.2 uT gave an OR around 2.5 compared with fields below 0.05 uT."

The effect of electromagnetic fields on cells *in vitro* and experimental animals

Today, a great deal of research has been done on the effects of EMFs on both cell structures and experimental animals, mostly rats. If the impact of low-level EMF exposure on skin cancer in rats were to be evaluated, one would have to use a corresponding wave-length. For example, GSM 1800 MHz would be useful for rats 7 cm in length. So far, however, no such experiment has been reported to specifically promote skin cancer in rats by low level resonant EMF exposure.

Haider et al. [9] investigated the effects of radio frequency (RF) EMF on chromosomes, and found that "Radiofrequency radiation in the immediate vicinity of broadcasting antennae yields moderate but statistically significant clastogenicity." Microwave exposure also affect sperm count, as stated by Weyandt et al. [10]: "The microwave exposed soldiers showed a significant decline in sperm count ($p=0.0085$)."

High-power radio stations may also increase leukemia according to a study by Michelozzi et al. [11], who found that "The risk of childhood leukemia was higher than expected for the distance up to 6 km from the radio station (standardized incidence rate=2.2) and there was a significant decline in risk with increasing distance both for male mortality and childhood leukaemia." A comparison of cows pastured close to and far from radio transmitters regarding the formation of micronuclei in bovine peripheral erythrocytes was done by Boscolo et al. [12]. They found that "cows in the vicinity of the transmitters had 0.6 micronuclei/1000 cells, while cows in the control group had 0.1/1000 cells; $p<0.01$."

Experiments have shown a clear impact of EMF at the cellular level. The effects of 50 Hz EMF exposure on apoptosis and differentiation in a neuroblastoma cell line was investigated by Pirozzoli et al. [13], whose data suggest "a possible role of 50 Hz and 1mT ELF-MF in interfering with regulation of the onset of differentiative and apoptopic processes of actively proliferating cells."

Cellular immunity was examined by looking into microwave irradiation and its effect on tumor necrosis factor production in mouse cells by Fesenko et al. [14]. They stated that "A significant enhancement of TNF production was found at 1 uW/cm^2. Further study is needed to elucidate the mechanism of the immunomodulating effects of microwaves."

Electromagnetic fields, the immune system, and well-being

Much of the research on EMF and health is today focused on mobile phone systems and handsets. Navarro et al. [15] demonstrated that "loss of appetite is the most relevant symptom that increases with exposure intensity from cellular phone base stations. Irritability, discomfort, fainting, difficulty in concentrating and fatigue also show a significant increment with exposure intensity ($p<0.05$)."

Stress hormones are affected by low-level RF EMF. According to Vangleova et al. [16], "Low-level exposures with specific absorption of 0.1127 J/kg caused significant increase in the 24-hour excretion of 11-OCS and disorders in its circadian rhythm were found in the exposed operators."

A good review of the biological effects of high- and extremely high-frequency electromagnetic fields was done by Mileva et al. [17], who found evidence that "non-thermal microwave effects do exist and may play a significant role."

Boscolo et al. [18] demonstrated that the immune system of women is affected by radio/television broadcasting towers. "The study demonstrates that high-frequency electromagnetic fields (ELMFs) reduce cytotoxic activity in the peripheral blood of women without a dose-response effect. Exposure to ELMFs induces a modification of immune parameters in humans."

Workers exposed to EMF and polychlorinated bisphenyls were compared in terms of prostate cancer mortality by Charles et al. [19], who stated that "The odds ratio (OR) for EMF exposed workers was 2 and for PCB 1.47. Non-white had EMF OR=3.67. There is an association between EMF and prostate cancer."

Ray and Behari [20] also measured the effect of low level EMF exposure on rats after 60 days, 600 uW, 7.5 GHz. They found that the exposed rats "tended to eat and drink less. It is proposed that a nonspecific stress response due to microwave exposure and mediated through the central nervous system is responsible for the observed physiological changes." It is interesting that both men and rodents seem to lose appetite when exposed to low-level radiation [15,20].

Conclusions

This brief study gives no evidence that increased travel is the main cause of increased mortality in malignant melanoma since 1955. We found, however, a strong connection between the start of FM broadcasting and increased mortality from malignant melanoma of the skin in all investigated countries. The fact that melanoma mortality starts to increase **earlier** than the incidence implies that an environmental factor other than sunshine affects the survival probability of melanoma patients. This is further underscored by the fact that melanoma deaths can show peaks of the kind noticed in France during 1968.

We believe this environmental factor to be radio frequency electromagnetic radiation, which is capable of (RF) affecting the proper function of cell repair and auto-immune system mechanisms in the human body. This conclusion is supported by other studies pointing at the effects that RF EMF may have on the immune defense system, cell repair, and apoptosis mechanisms.

The most important task now is to start action based on the knowledge already possessed, without waiting for another 20 years for more basic research. We need healthy ways of distributing high bit-rate communication to all homes, and new forms of mobile handsets, communicating without any hazardous effects on living cells.

Acknowledgements

The authors would like to acknowledge the support received from the Karolinska Institute and the Cancer and Allergy Foundation.

References:

1. Paulsson L-E: Swedish Radiation Protection Institute, letter dated 030128, dnr 842/4165/02
2. Spri tryck 257, Koncensusuttalande, Att förebygga utveckling av malignt hudmelanom. (In Swedish), ISBN 91-7926-122-1; Spris förlag; 1995
3. Hallberg Ö, Johansson O: Melanoma incidence and frequency modulation (FM) broadcasting. Arch Envir Health; 2002; 51: 32–40
4. Luftfartsverket, Charter travelling statistics 1962–89, Luftfartsverkets författningssamling 1987: 20. Reproduced in: *Nationalencyklopedin*; "Charterflyg", Bokförlaget Bra Böcker, ISBN 91-7024-621-1
5. Holm L-E: Swedish Radiation Protection Institute, letter dated 2001-05-09, dnr 842/1630/01
6. Holt JA: Changing epidemiology of malignant melanoma in Queensland. Med J Aust; 1980; 1: 619–20
7. Dolk H, Shaddik G, Walls P et al: Cancer incidence near radio and television transmitters in Great Britain, I and II. Am J Epidemiol. 1997; 145; 1–17
8. Tynes T, Klaeboe L, Haldorsen T: Exposure to 50 Hz electromagnetic fields and cutaneous malignant melanoma in adults, 6th International Congress of the European Bioelectromagnetics Association; 2003 Nov 13–15, Budapest, Hungary
9. Haider T, Knasmueller S, Kundi M, Haider M: Clastrogenic effects of radio frequency radiation on chromosomes of Tradescantia. Mutation Research Letters, 1994; 324: 65–68
10. Weyandt TB, Schrader SM, Turner TW, Simon SD: Semen analysis of military personnel associated with military duty assignments. Reproductive Toxicology, 1996; 10: 521–28
11. Michelozzi P, Capon A, Kirchmayer U et al: Adult and childhood leukaemia near a high-power radio station in Rome, Italy. Am J Epidemiol, 2002; 155: 1096–103
12. Balode Z: Assessment of radio-frequency electromagnetic radiation by micronucleus test in bovine peripheral erythrocytes. Sci Total Environ, 1996; 189: 81–85
13. Pirozzoli MC, Marino C, Lovisolo GA et al: Effects of 50 Hz electromagnetic field exposure on apoptosis and differentiation in a neuroblastoma cell line. Bioelectromagnetics, 2003; 24: 510–16
14. Fesenko EE, Makar VR, Novoselova EG, Sadovnikov VB: Microwaves and cellular immunity. I. Effect of whole body microwave irradiation on tumour necrosis factor production in mouse cells. Bioelectrochem Bioenerget, 1999; 49: 29–35
15. Navarro EA, Segura J, Gómez-Perretta C et al: About the effect of microwave exposure from cellular phone base stations: a first approach. 2nd Int Workshop on Biological Effects of Electromagnetic Fields; 2003 Oct 7–11 Rhodes, Greece
16. Vangleova K, Israel M, Mihaylov S: The effect of low level radio frequency electromagnetic radiation on the excretion rates of stress hormones in operators during 24-hour shifts. Cent Eur J Publ Health, 2002; 10: 24–28
17. Mileva K, Georgieva B, Radicheva N: About the biological effects of high and extremely high frequency electromagnetic fields. Acta Physiol Pharmacol Bulg, 2003; 27: 89–199
18. Boscolo P, Di Sciascio MB, D'Ostilio S et al: Effects of electromagnetic fields produced by radio television broadcasting stations on the immune system of women. Sci Total Environ, 2001; 273: 1–10
19. Charles LE, Loomis D, Shy CM et al: Electromagnetic fields, polychlorinated bisphenyls, and prostate cancer mortality in electric utility workers. Am J Epidemiol, 2003; 157: 683–91
20. Ray S, Behari J: Physiological changes in rats after exposure to low levels of microwaves. Radiat Res, 1990; 123: 199–202

National audit

Radio waves above a certain level can cause heating effects to the body. International guidelines have been set to keep exposure to radio waves below that level.

Mobile phone network operators in the UK have agreed to comply with these international guidelines. Exposure to radio wave emissions from base stations has been calculated to be thousands of times lower than the maximum levels stipulated by the guidelines.

Some independent measurements have already been made which show compliance. However, starting from Autumn 2000, a comprehensive audit of base stations is being carried out by the Radiocommunications Agency. Base stations will be measured to confirm their compliance with guidelines on emission levels, and the results will be freely available from the Agency (see Information). The audit begins with base stations on school premises.

Information

- Radiocommunications Agency (RA)
  website: www.radio.gov.uk
- RA Audit website:
  www.radio.gov.uk/document/ra_info/ra377.htm
- Department of Health
  website: www.doh.gov.uk/mobile.htm
- report of the Stewart Group
  website: www.iegmp.org.uk
- Department for Education and Employment
  website: www.dfee.gov.uk/a-z/mobilephones.html
- National Radiological Protection Board (NRPB)
  website: www.nrpb.org.uk

or write to: NRPB, Chilton, Didcot, OX11 0RQ

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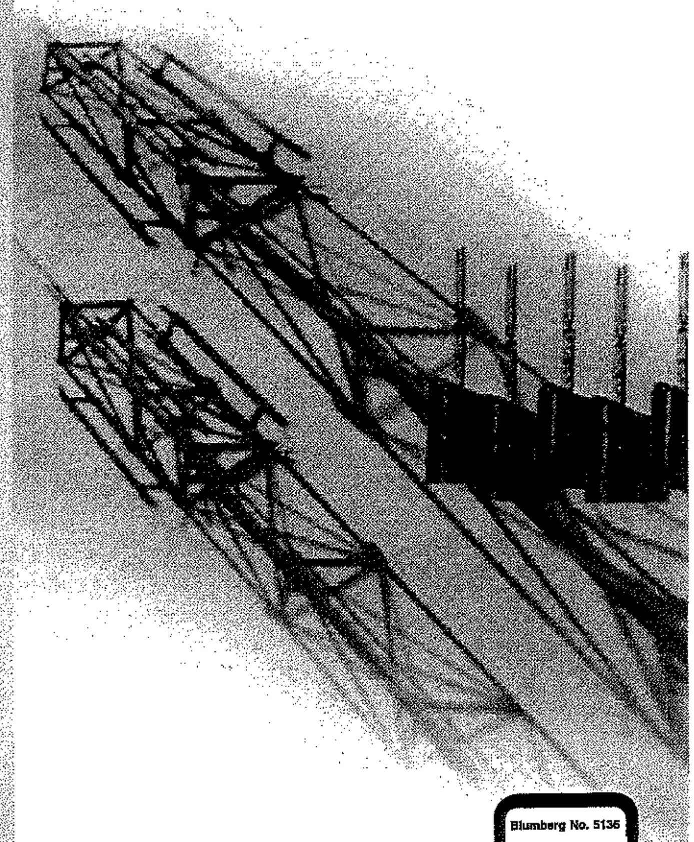
DH Department of Health

Mobile phone Base stations and Health



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Over half the people in Britain have mobile phones. In a wide variety of settings - at work, at home, out and about, for convenience and security - they have become part of our way of life.

Base stations and "cells"

Base stations are radio transmitters and receivers which form an essential link in mobile phone communications. They have antennas, mounted either on freestanding masts or on existing structures and buildings, which use radio signals similar to those used in TV and radio broadcasting. Calls pass through these antennas as people use mobile phones within their areas of coverage - their "cells".

Cells usually have a radius of several kilometres. However, more base stations are needed where mobile phone usage is high. So, in rural areas cells can have a radius of 10 km, while in towns and cities their radius may be less than a few hundred metres. They overlap at the edges to ensure that mobile phone users remain within range of a base station.

Without sufficient base stations in the right locations, mobile phones will not work. But concerns about health are sometimes expressed by people who live or work close to where they are sited.

Independent assessment and research

A group of independent experts led by Sir William Stewart has investigated possible health effects posed by mobile phone technology including base stations, on behalf of the Government. The group looked at recent research, took evidence from scientists, and listened to the views of the public at open meetings around the UK. Their report was published in May 2000.

Their conclusion was that:

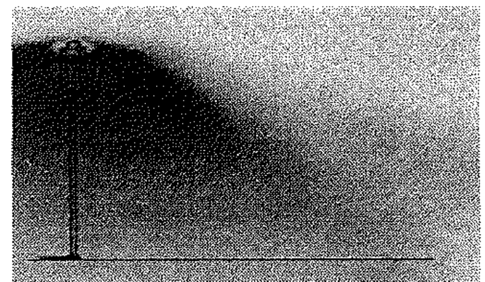
"The balance of evidence indicates that there is no general risk to the health of people living near base stations, on the basis that exposures are expected to be small fractions of guidelines".

Gaps in scientific knowledge led the Stewart Group to recommend a precautionary approach to the use of mobile phones and base stations until more research findings become available. They added that in some cases people's well-being may be adversely affected by insensitive siting of base stations.

Further research is now being set up to keep pace with developments in mobile phone technology. (See companion leaflet, *Mobile Phones and Health*)

Base stations on or near schools

Although the exposure from base stations will be many times lower than from using a mobile phone, the Stewart Group acknowledged that there was some public concern about base stations located on or near schools. The pattern of radio waves emitted from a base station is generally even, but there is a zone within each cell where the concentration of waves will be slightly higher (see illustration). The base station operator will be able to provide information about the pattern of radio wave emissions if a school or parents are concerned about the possibility that this zone includes a school or any part of its grounds.



Within the overall distribution of radio waves from a base station across its cell, there is a zone where the concentration is higher than elsewhere.

At ground level, this zone is usually some distance from the base station. The radio waves within it are still far below the levels for safety specified in international guidelines.

In hospitals and aeroplanes

The radio signals emitted by mobile phone systems can interfere with sensitive electronic equipment. In hospitals, aeroplanes and other restricted areas, observe the warning signs and switch off your mobile when required.

SAR values

It is possible to measure how much radio wave energy your body receives from each model of mobile phone. This is called the specific absorption rate or SAR. From 2001, there will be a European Standard method for measuring the SAR. This information will be provided to consumers for each model of mobile phone sold in the UK from this time. Users may wish to take account of these relative SAR values when choosing a mobile phone. All models sold in the UK already meet international exposure guidelines.

Hands-free kit

The level of effectiveness of hands free kit to reduce SAR is still uncertain. Further research is being carried out to investigate SAR levels when using phones with hands free kit and the results will be made available as soon as they are completed.

Action by Government

The advice in this leaflet is based on a report for the Government, published in May 2000, by a group of independent experts led by Sir William Stewart. The group looked at recent research, took evidence from scientists, and listened to the views of the public at open meetings around the UK.
The Government is already putting some of its main recommendations into practice. On the advice of the Stewart Group further major research, funded by government and the mobile phone industry, is now being undertaken.

For further information visit the websites

- Department of Health
  www.doh.gov.uk/mobile.htm
- Report of the Stewart Group
  www.iegmp.org.uk
- World Health Organisation
  www.who.int
- National Radiological Protection Board
  www.nrpb.org.uk

or write to: NRPB, Chilton, Didcot, OX11 0RQ

If you are concerned about a mobile phone base station in your neighbourhood, look for the companion leaflet *Mobile phone Base stations and Health.*

This information is published jointly with:

SCOTTISH EXECUTIVE

THE NORTHERN IRELAND EXECUTIVE
(Irish version available.)

THE NATIONAL ASSEMBLY FOR WALES

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Chlorine Free Paper
22883 5p 200k Sept 03 (COL) 271117

DH Department of Health

Mobile phones
and Health

Using mobile phones

Over half the people in Britain have mobile phones. In a wide variety of settings - at work, at home, out and about, for convenience and security - they have become part of our way of life.

Mobile phones [illegible] that emit and receive radio waves. These connect each phone to a network of base stations, so that users can make and receive calls.

Radio waves have been used for communication for over 100 years. But the speed with which mobile phones have become so widely used is unprecedented. This has led to public concern about their possible impact on health.

This leaflet offers the latest information and advice based on both current knowledge and remaining uncertainties so that people can make their own informed choices about how to use mobile phones. It also outlines further work that is under way.

Independent assessment

Radio waves emitted above a certain level can cause heating effects in the body. International guidelines seek to ensure that exposure is kept below that level. All mobile phones sold in the UK meet these guidelines.

The balance of current research evidence suggests that exposures to radio waves below levels set out in international guidelines do not cause health problems for the general population. However, there is some evidence that changes in brain activity can occur below these guidelines, but it isn't clear why. There are significant gaps in our scientific knowledge. This has led a group of independent experts – commissioned by Government and headed by Sir William Stewart – to recommend "a precautionary approach" to the use of mobile phones until more research findings become available.

If you use a mobile phone, you can choose to minimise your exposure to radio waves. These are ways to do so:

- keep your calls short
- consider relative SAR values (see over page) when buying a new phone.

Driving

Anything that distracts a driver increases the risk of an accident - posing a threat to pedestrians, cyclists, passengers and other road users. You must be in proper control of your vehicle while you are driving. Any lack of concentration or momentary inattention may result in your being prosecuted. Even using a hands-free phone while driving will distract you. *For more details see leaflet "Mobile Phones and Driving" issued by the Department of the Environment, Transport and the Regions.*

Children and young people under 16

Mobile phones are very popular with young people and have obvious attractions for personal security and keeping in touch with others. Parents and young people should make their own informed choices about the use of mobile phones. The current balance of evidence does not show health problems caused by using mobile phones. However the research does show that using mobile phones affects brain activity. There are also significant gaps in our scientific knowledge. Because the head and nervous system are still developing into the teenage years, the expert group considered that if there are any unrecognised health risks from mobile phone use, then children and young people might be more vulnerable than adults.

The expert group has therefore recommended that in line with a precautionary approach, the widespread use of mobile phones by children (under the age of 16) should be discouraged for non-essential calls.

In the light of this recommendation the UK Chief Medical Officers strongly advise that where children and young people do use mobile phones, they should be encouraged to:

- use mobile phones for essential purposes only
- keep all calls short - talking for long periods prolongs exposure and should be discouraged

The UK CMOs recommend that if parents want to avoid their children being subject to any possible risk that might be identified in the future, the way to do so is to exercise their choice not to let their children use mobile phones.

At work

Mobile phones are often used at work. They can have benefits for safety, efficiency and convenience of employers and staff. Employers have legal duties to protect the health and safety of their employees. The Health and Safety Executive advises employers that they should instruct staff not to use mobile phones while driving, or doing anything else where safety is important and their use might interfere with concentration.

Where employers require staff to use a mobile phone, and concerns about possible health impacts are raised, employers could respond by, for example:

- explaining that mobile phones operate within international guidelines
- giving staff a copy of this leaflet
- discussing with concerned staff ways to reduce mobile phone use.

EXHIBIT
IJ41
Blumberg No. 5136

The EMR Policy Institute
A Non-Profit Corporation www.EMRPolicy.org

Advancing Sound Public Policy
on the Use of Electromagnetic Radiation (EMR)
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FOR IMMEDIATE RELEASE

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INTERNATIONAL ASSOCIATION OF FIREFIGHTERS (IAFF) VOTES TO STUDY HEALTH EFFECTS OF CELL TOWERS ON FIRE STATIONS

Call for Moratorium on New Cell Towers on Fire Stations Until Health Effects Can Be Studied

Boston, MA – August 24, 2004 – Firefighters returned to their home stations throughout the United States and Canada following last week's IAFF convention after passing a resolution to study the health effects of cell towers placed on the fire stations where they work and live.

Added to the resolution was an amendment calling for the IAFF to support a moratorium on the placement of new cell towers on fire stations until the completion of the study.

In many parts of the U.S. and Canada, the wireless industry has sought to place cell towers on fire stations because of their strategic locations. Fire stations tend to be located in densely populated areas, many of them near main highways, making them attractive locations for cell towers to maximize coverage. The wireless industry is not alone in the benefits of placing cell towers on these stations. Municipalities receive revenue from the wireless companies in exchange for locating the antennas on fire station property.

Lt. Ron Cronin of the Brookline, MA Fire Department and Acting Lt. Joe Foster of the Vancouver Fire Department and Vice President of Vancouver, B.C. Local #18 spearheaded the passage of the resolution.

"Some firefighters with cell towers currently located on their stations are experiencing symptoms that put our first responders at risk. It is important to be sure we understand what effects these towers may have on the firefighters living in these stations," Cronin explained. "If the jakes in the fire house are suffering from headaches, can't respond quickly and their ability to make decisions is clouded by a sort of brain fog, then entire communities they are protecting will clearly be at risk. No one wants the guys responding to their family emergency to be functioning at anything less than 100 percent capacity."

A recent pilot study of six California firefighters, first publicly revealed at the IAFF convention by medical writer and study organizer Susan Foster Ambrose of San Diego, CA, raises concern about the safety of fire fighters working and sleeping in stations with towers.

The study, conducted by Dr. Gunnar Heuser of Agoura Hills, CA, focused on neurological symptoms of six firefighters who had been working for up to five years in stations with cell towers. Those symptoms included slowed reaction time, lack of focus, lack of impulse control, severe headaches, anesthesia-like sleep, sleep deprivation, depression, and tremors.

Dr. Heuser, along with Dr. J. Michael Uszler of Santa Monica, CA, used functional brain scans - SPECT scans - to assess any changes in the brains of the six firefighters as compared to healthy brains of men of the same age. Computerized psychological testing known as TOVA was used to study reaction time, impulse control, and attention span.

Disturbingly, the SPECT scans revealed a pattern of abnormal change which was concentrated over a wider area than would normally be seen in brains of individuals exposed to toxic inhalation, as might be expected from fighting fires. Dr. Heuser indicated the only plausible explanation at this time would be RF radiation exposure. Additionally, the TOVA testing revealed among the six firefighters delayed reaction time, lack of impulse control, and difficulty in maintaining mental focus.

Because of increasing complaints among firefighters with cellular antennas on their stations coupled with the California study showing damage among the six firefighters tested, a group of five individuals spread across two provinces and three states worked with Southern California firefighters to draft the resolution put before the IAFF membership last week. Lt. Ron Cronin and Acting Lt. Joe Foster were joined by Dr. Magda Havas of Trent University in Peterborough, Ontario, Vermont-based Janet Newton - president of the EMR Policy Institute, and Susan Foster Ambrose.

"It is imperative to understand that in spite of the build out of an extensive wireless infrastructure in the U.S. and Canada," explained Ambrose, "we have no safety standards for cell towers. There are only regulatory standards, not proven safety standards. The Heuser Study in California calls into question whether or not we are sacrificing the health and well being of our countries' first responders for the convenience of a technology we've come to rely upon."

Considering approximately 80 percent of the firefighters attending last week's convention voted in favor of a medical study with the spirit of a cell tower moratorium attached, it appears firefighters throughout the U.S. and Canada share that concern.

This study has far-reaching public health implications in view of the fact that the wireless industry pays local governments to place cell towers, not only on fire stations, but also on top of schools and municipal buildings.

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Gunnar Heuser, M.D., Ph.D., F.A.C.P.: 818.865.1858; www.toxgun.com
J. Michael Uszler, M.D.: 310.264.0080; www.santamonicaimaging.com

# # #

Blumberg No. 5138
EXHIBIT
IJ42

1/21/05

Studies reporting biological effects of radiofrequency radiation (RFR) at low intensities

(1) Balode (1996)- blood cells from cows from a farm close and in front of a radar showed significantly higher level of severe genetic damage.

(2) Boscol et al. (2001)- RFR from radio transmission stations (0.005 mW/cm^2) affects immunological system in women.

(3) Chiang et al. (1989)- people lived and worked near radio antennae and radar installations showed deficits in psychological and short-term memory tests.

(4) de Pomerai et al. (2000, 2002) reported an increase in a molecular stress response in cells after exposure to a RFR at a SAR of 0.001 W/kg. This stress response is a basic biological process that is present in almost all animals - including humans.

(5) de Pomerai et al. (2003) RFR damages proteins at 0.015-0.020 W/kg.

(6) D'Inzeo et al. (1988)- very low intensity RFR (0.002 – 0.004 mW/cm^2) affects the operation of acetylcholine-related ion-channels in cells. These channels play important roles in physiological and behavioral functions.

(7) Dolk et al. (1997)- a significant increase in adult leukemias was found in residence who lived near the Sutton Coldfield television (TV) and frequency modulation (FM) radio transmitter in England.

(8) Dutta et al. (1989) reported an increase in calcium efflux in cells after exposure to RFR at 0.005 W/kg. Calcium is an important component of normal cellular functions.

(9) Fesenko et al. (1999) reported a change in immunological functions in mice after exposure to RFR at a power density of 0.001 mW/cm^2.

(10) Hjollund et al. (1997)- sperm counts of Danish military personnel, who operated mobile ground-to-air missile units that use several RFR emitting radar systems (maximal mean exposure 0.01 mW/cm^2), were significantly low compared to references.

(11) Hocking et al. (1996)- an association was found between increased childhood leukemia incidence and mortality and proximity to TV towers.

(12) Ivaschuk et al. (1999)- short-term exposure to cellular phone RFR of very low SAR (0.026 W/kg) affected a gene related to cancer.

(13) Kolodynski and Kolodynska (1996)- school Children lived in front of a radio station had less developed memory and attention, their reaction time was slower, and their neuromuscular apparatus endurance was decreased.

(14) Kwee et al. (2001)- 20 minutes of cell phone RFR exposure at 0.0021 W/kg increased stress protein in human cells.

(15) Lebedeva et al. (2000)- brain wave activation was observed in human subjects exposed to cellular phone RFR at 0.06 mW/cm^2.

(16) Magras and Xenos (1999) reported a decrease in reproductive function in mice exposed to RFR at power densities of 0.000168 - 0.001053 mW/cm^2.

(17) Mann et al. (1998)- a transient increase in blood cortisol was observed in human subjects exposed to cellular phone RFR at 0.02 mW/cm^2. Cortisol is a hormone involved in stress reaction.

(18) Marinelli et al. (2004)- exposure to 900-MHz RFR at 0.0035 W/kg affected cell's self-defense responses.

(19) Michelozzi et al. (1998)- leukemia mortality within 3.5 km (5,863 inhabitants) near a high power radio-transmitter in a peripheral area of Rome was higher than expected.

(20) Michelozzi et al. (2002)- childhood leukemia higher at a distance up to 6 km from a radio station.

(21) Navakatikian and Tomashevskaya (1994)- RFR at low intensities (0.01 - 0.1 mW/cm^2; 0.0027- 0.027 W/kg) induced behavioral and endocrine changes in rats. Decreases in blood concentrations of testosterone and insulin were reported.

(22) Novoselova et al. (1999)-low intensity RFR (0.001 mW/cm^2) affects functions of the immune system.

(23) Novoselova et al. (2004)- chronic exposure to RFR (0.001 mW/cm^2) decreased tumor growth rate and enhanced survival in mice.

(24) Park et al. (2004) higher mortality rates for all cancers and leukemia in some age groups in the area near the AM radio broadcasting towers.

(25) Persson et al. (1997) reported an increase in the permeability of the blood-brain barrier in mice exposed to RFR at 0.0004 - 0.008 W/kg. The

blood-brain barrier envelops the brain and protects it from toxic substances.

(26) Phillips et al. (1998) reported DNA damage in cells exposed to RFR at SAR of 0.0024 - 0.024 W/kg.

(27) Polonga-Moraru et al. (2002) change in membrane of cells in the retina (eye) after exposure to RFR at 15 $\mu W/cm^2$.

(28) Pyrpasopoulou et al. (2004) exposure to cell phone radiation during early gestation at SAR of 0.0005 W/kg (5 $\mu W/cm^2$) affected kidney development in rats.

(29) Salford et al. (2003)- nerve cell damage in brain of rats exposed for 2 hrs to GSM signal at 0.02 W/kg.

(30) Santini et al. (2002)- increase in complaint frequencies for tiredness, headache, sleep disturbance, discomfort, irritability, depression, loss of memory, dizziness, libido decrease, in people who lived within 300 m of mobile phone base stations.

(31) Sarimov et al. (2004)- GSM microwaves affect human lymphocyte chromatin similar to stress response at 0.0054 W/kg.

(32) Schwartz et al. (1990)- calcium movement in the heart affected by RFR at SAR of 0.00015 W/kg. Calcium is important in muscle contraction. Changes in calcium can affect heart functions.

(33) Somosy et al. (1991)- RFR at 0.024 W/kg caused molecular and structural changes in cells of mouse embryos.

(34) Stagg et al. (1997)- glioma cells exposed to cellular phone RFR at 0.0059 W/kg showed significant increases in thymidine incorporation, which may be an indication of an increase in cell division.

(35) Stark et al. (1997)- a two- to seven-fold increase of salivary melatonin concentration was observed in dairy cattle exposed to RFR from a radio transmitter antenna.

(36) Tattersall et al. (2001)- low-intensity RFR (0.0016 - 0.0044 W/kg) can modulate the function of a part of the brain called the hippocampus, in the absence of gross thermal effects. The changes in excitability may be consistent with reported behavioral effects of RFR, since the hippocampus is involved in learning and memory.

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(37) Vangelova et al. (2002)- operators of satellite station exposed to low dose (0.1127 J/kg) of RFR over a 24-hr shift showed an increased excretion of stress hormones.

(38) Velizarov et al. (1999) showed a decrease in cell proliferation (division) after exposure to RFR of 0.000021 - 0.0021 W/kg.

(39) Veyret et al. (1991)- low intensity RFR at SAR of 0.015 W/kg affects functions of the immune system.

(40) Wolke et al. (1996)- RFR at 0.001W/kg affects calcium concentration in heart muscle cells of guinea pigs.

EXHIBIT
IJ 43

Blumberg No.

Benevento Resolution

The International Commission for Electromagnetic Safety (ICEMS) held an international conference entitled *"The Precautionary EMF Approach: Rationale, Legislation and Implementation"*, hosted by the City of Benevento, Italy, on February 22, 23 & 24, 2006. The meeting was dedicated to W. Ross Adey, M.D. (1922-2004). The scientists at the conference endorsed and extended the 2002 Catania Resolution and resolved that:

1. **More evidence has accumulated suggesting that there are adverse health effects from occupational and public exposures to electric, magnetic and electromagnetic fields, or EMF[1], at current exposure levels. What is needed, but not yet realized, is a comprehensive, independent and transparent examination of the evidence pointing to this emerging, potential public health issue.**
2. **Resources for such an assessment are grossly inadequate despite the explosive growth of technologies for wireless communications as well as the huge ongoing investment in power transmission.**
3. **There is evidence that present sources of funding bias the analysis and interpretation of research findings towards rejection of evidence of possible public health risks.**
4. **Arguments that weak (low intensity) EMF cannot affect biological systems do not represent the current spectrum of scientific opinion.**
5. **Based on our review of the science, biological effects can occur from exposures to both extremely low frequency fields (ELF EMF) and radiation frequency fields (RF EMF). Epidemiological and *in vivo* as well as *in vitro* experimental evidence demonstrates that exposure to some ELF EMF can increase cancer risk in children and induce other health problems in both children and adults. Further, there is accumulating epidemiological evidence indicating an increased brain tumor risk from long term use of mobile phones, the first RF EMF that has started to be comprehensively studied. Epidemiological and laboratory studies that show increased risks for cancers and other diseases from occupational exposures to EMF cannot be ignored. Laboratory studies on cancers and other diseases have reported that hypersensitivity to EMF may be due in part to a genetic predisposition.**
6. **We encourage governments to adopt a framework of guidelines for public and occupational EMF exposure that reflect the Precautionary Principle[2] -- as some nations have already done. Precautionary strategies should be based on design and performance standards and may not necessarily define numerical thresholds because such thresholds may erroneously be interpreted as levels below which no adverse effect can occur. These strategies should include:**
   - **6.1. Promote alternatives to wireless communication systems, e.g., use of fiber optics and coaxial cables; design cellular phones that meet safer performance specifications, including radiating away from the head; preserve existing land line phone networks; place power lines underground in the vicinity of populated areas, only siting them in residential neighborhoods as a last resort;**
   - **6.2. Inform the population of the potential risks of cell phone and cordless phone use. Advise consumers to limit wireless calls and use a land line for long conversations.**
   - **6.3. Limit cell phone and cordless phone use by young children and teenagers to the lowest possible level and urgently ban telecom companies from marketing to them.**
   - **6.4. Require manufacturers to supply hands-free kits (via speaker phones or ear phones), with each cell phone and cordless phone.**

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[1] EMF, in this resolution, refers to zero to 300 GHz.

[2] The Precautionary Principle states when there are indications of possible adverse effects, though they remain uncertain, the risks from doing nothing may be far greater than the risks of taking action to control these exposures. The Precautionary Principle shifts the burden of proof from those suspecting a risk to those who discount it.

6.5. Protect workers from EMF generating equipment, through access restrictions and EMF shielding of both individuals and physical structures.

6.6. Plan communications antenna and tower locations to minimize human exposure. Register mobile phone base stations with local planning agencies and use computer mapping technology to inform the public on possible exposures. Proposals for city-wide wireless access systems (e.g. Wi-Fi, WIMAX, broadband over cable or power-line or equivalent technologies) should require public review of potential EMF exposure and, if installed, municipalities should ensure this information is available to all and updated on a timely basis.

6.7. Designate wireless-free zones in cities, in public buildings (schools, hospitals, residential areas) and, on public transit, to permit access by persons who are hypersensitive to EMF.

7. ICEMS[3] is willing to assist authorities in the development of an EMF research agenda. ICEMS encourages the development of clinical and epidemiological protocols for investigations of geographical clusters of persons with reported allergic reactions and other diseases or sensitivities to EMF, and document the effectiveness of preventive interventions. ICEMS encourages scientific collaboration and reviews of research findings.

We, the undersigned scientists, agree to assist in the promotion of EMF research and the development of strategies to protect public health through the wise application of the precautionary principle.

Signed:

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Carl F. Blackman, President, Bioelectromagnetics Society (1990-91), Raleigh, NC, USA
Martin Blank, Department of Physiology, Columbia University, New York, USA
Natalia Bobkova, Institute of Cell Biophysics, Pushchino, Moscow Region
Francesco Boella, National Inst. Prevention & Worker Safety, Venice, Italy
Zhaojin Cao, National Institute Environmental Health, Chinese Center for Disease Control, China
Sandro D'Allessandro, Physician, Mayor of Benevento, Italy, (2001-2006)
Enrico D'Emilia, National Institute for Prevention and Worker Safety, Monteporzio, Italy
Emilio Del Giudulce, National Institute for Nuclear Physics, Milan, Italy
Antonella De Ninno,Italian National Agency For Energy, Environment & Technology, Frascati, Italy
Alvaro A. De Sallas, Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil
Livio Giuliani, East Veneto&South Triol, National Inst. Prevention & Worker Safety, Camerino University
Yury Grigoryev, Institute of Biophysics; Chairman, Russian National Committee NIERP
Settimo Grimaldi, Inst. Neurobiology & Molecular Medicine, National Research, Rome, Italy
Lennart Hardell, Department of Oncology, University Hospital, Orebro, Sweden
Magda Havas, Environmental & Resource Studies, Trent University, Ontario, Canada
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Date of Release: September 19, 2006. For more information, contact Elizabeth Kelley, Managing Secretariat, International Commission For Electromagnetic Safety (ICEMS), Montepulciano, Italy. Email: info@icems.eu Website: www.icems.eu

[3] International Commission For Electromagnetic Safety. For information, link to www.icems.eu.

CATANIA RESOLUTION
September 2002

The Scientists at the International Conference
"State of the Research on Electromagnetic Fields – Scientific and Legal Issues",
organized by ISPESL*, the University of Vienna and the City of Catania,
held in Catania (Italy) on September 13th – 14th, 2002, agree to the following:

1. **Epidemiological and *in vivo* and *in vitro* experimental evidence demonstrates the existence of electromagnetic field (EMF) induced effects, some of which can be adverse to health.**
2. **We take exception to arguments suggesting that weak (low intensity) EMF cannot interact with tissue.**
3. **There are plausible mechanistic explanations for EMF-induced effects which occur below present ICNIRP and IEEE guidelines and exposure recommendations by the EU.**
4. **The weight of evidence calls for preventive strategies based on the precautionary principle. At times the precautionary principle may involve prudent avoidance and prudent use.**
5. **We are aware that there are gaps in knowledge on biological and physical effects, and health risks related to EMF, which require additional independent research.**
6. **The undersigned scientists agree to establish an international scientific commission to promote research for the protection of public health from EMF and to develop the scientific basis and strategies for assessment, prevention, management and communication of risk, based on the precautionary principle.**

Fiorella Belpoggi, Fondazione Ramazzini, Bologna, Italy
Carl F. Blackman, President of the Bioelectromagnetics Society (1990-1991), Raleigh, USA
Martin Blank, Department of Physiology, Columbia University, New York, USA
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Abraham R. Liboff, Department of Physics, Oakland University, USA
Wolfgang Löscher, Department of Pharmacology, Toxicology and Pharmacy, School of Veterinary Medicine, Hannover, Germany
Kjell Hansson Mild, President of the Bioelectromagnetics Society (1996-1997), National Institute of Working Life, Umea, Sweden
Wilhelm Mosgöller, Institute for Cancer Research, University of Vienna, Austria
Elihu D. Richter, Head, Unit of Occupational and Environmental Medicine, School of Public Health, Hebrew University-Hadassah, Jerusalem, Israel.
Umberto Scapagnini, Neuropharmacology, University of Catania, Italy, Member of the Research Comm. of the European Parliament
Stanislaw Szmigielski, Military Institute of Hygiene and Epidemiology, Warsaw, Poland

*** = Istituto Superiore per la Prevenzione e la Sicurezza del Lavoro, Italy**
(National Institute for Prevention and Work Safety, Italy)

TIMES ONLINE

EXHIBIT IJ44

From The Sunday Times
April 22, 2007

Cancer clusters at phone masts

Daniel Foggo

SEVEN clusters of cancer and other serious illnesses have been discovered around mobile phone masts, raising concerns over the technology's potential impact on health.

Studies of the sites show high incidences of cancer, brain haemorrhages and high blood pressure within a radius of 400 yards of mobile phone masts.

One of the studies, in Warwickshire, showed a cluster of 31 cancers around a single street. A quarter of the 30 staff at a special school within sight of the 90ft high mast have developed tumours since 2000, while another quarter have suffered significant health problems.

The mast is being pulled down by the mobile phone after the presentation of the evidenceoperator O2 by local protesters. While rejecting any links to ill-health, O2 admitted the decision was "clearly rare and unusual".

Phone masts have provoked protests throughout Britain with thousands of people objecting each week to planning applications. There are about 47,000 masts in the UK.

Dr John Walker, a scientist who compiled the cluster studies with the help of local campaigners in Devon, Lincolnshire, Staffordshire and the West Midlands, said he was convinced they showed a potential link between the angle of the beam of radiation emitted from the masts' antennae and illnesses discovered in local populations.

"Masts should be moved away from conurbations and schools and the power turned down," he said.

Some scientists already believe such a link exists and studies in other European countries suggest a rise in cancers close to masts. In 2005 Sir William Stewart, chairman of the Health Protection Agency, said he found four such studies to be of concern but that the health risk remained unproven.

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EXHIBIT IJ45

SECTION 1

SUMMARY FOR THE PUBLIC

Cindy Sage, MA
Sage Associates
USA

Prepared for the BioInitiative Working Group
August 2007

Table of Contents

I. SUMMARY FOR THE PUBLIC

A. Introduction

You cannot see it, taste it or smell it, but it is one of the most pervasive environmental exposures in industrialized countries today. Electromagnetic radiation (EMR) or electromagnetic fields (EMFs) are the terms that broadly describe exposures created by the vast array of wired and wireless technologies that have altered the landscape of our lives in countless beneficial ways. However, these technologies were designed to maximize energy efficiency and convenience; not with biological effects on people in mind. Based on new studies, there is growing evidence among scientists and the public about possible health risks associated with these technologies.

Human beings are bioelectrical systems. Our hearts and brains are regulated by internal bioelectrical signals. Environmental exposures to artificial EMFs can interact with fundamental biological processes in the human body. In some cases, this can cause discomfort and disease. Since World War II, the background level of EMF from electrical sources has risen exponentially, most recently by the soaring popularity of wireless technologies such as cell phones (two billion and counting in 2006), cordless phones, WI-FI and WI-MAX networks. Several decades of international scientific research confirm that EMFs are biologically active in animals and in humans, which could have major public health consequences.

In today's world, everyone is exposed to two types of EMFs: (1) extremely low frequency electromagnetic fields (ELF) from electrical and electronic appliances and power lines and (2) radiofrequency radiation (RF) from wireless devices such as cell phones and cordless phones, cellular antennas and towers, and broadcast transmission towers. In this report we will use the term EMFs when referring to all electromagnetic fields in general; and the terms ELF and RF when referring to the specific type of exposure. They are both types of non-ionizing radiation, which means that they do not have sufficient energy to break off electrons from their orbits around atoms and ionize (charge) the atoms, as do x-rays, CT scans, and other forms of ionizing radiation. A glossary and definitions are provided in Section 18 to assist you. Some handy definitions you will probably need when reading about ELF and RF in this summary section (the language for measuring it) are shown with the references for this section.

B. Purpose of the Report

This report has been written by 14 (fourteen) scientists, public health and public policy experts to document the scientific evidence on electromagnetic fields. Another dozen outside reviewers have looked at and refined the Report.

The purpose of this report is to assess scientific evidence on health impacts from electromagnetic radiation below current public exposure limits and evaluate what changes in these limits are warranted now to reduce possible public health risks in the future.

Not everything is known yet about this subject; but what is clear is that the existing public safety standards limiting these radiation levels in nearly every country of the world look to be thousands of times too lenient. Changes are needed.

New approaches are needed to educate decision-makers and the public about sources of exposure and to find alternatives that do not pose the same level of possible health risks, while there is still time to make changes.

A working group composed of scientists, researchers and public health policy professionals (The BioInitiative Working Group) has joined together to document the information that must be considered in the international debate about the adequacy (or inadequacy) of existing public exposure standards.

This Report is the product of an international research and public policy initiative to give an overview of what is known of biological effects that occur at low-intensity EMFs exposures (for both radiofrequency radiation RF and power-frequency ELF, and various forms of combined exposures that are now known to be bioactive). The Report examines the research and current standards and finds that these standards are far from adequate to protect public health.

Recognizing that other bodies in the United States, United Kingdom, Australia, many European Union and eastern European countries as well as the World Health Organization are actively debating this topic, the BioInitiative Working Group has conducted a independent science and public health policy review process. The report presents solid science on this issue, and makes recommendations to decision-makers and the public. Conclusions of the individual authors, and overall conclusions are given in Table 2-1 (BioInitiative Overall Summary Chart).

Eleven (11) chapters that document key scientific studies and reviews identifying low-intensity effects of electromagnetic fields have been written by members of the BioInitiative Working Group. Section 16 and 17 have been prepared by public health and policy experts. These sectoins discusses the standard of evidence which should be applied in public health planning, how the scientific information should be evaluated in the context of prudent public health policy, and identifies the basis for taking precautionary and preventative actions that are proportionate to the knowledge at hand. They also evaluate the evidence for ELF that leads to a recommendation for new public safety limits (not precautionary or preventative actions, as need is demonstrated).

Other scientific review bodies and agencies have reached different conclusions than we have by adopting standards of evidence so unreasonably high as to exclude any conclusions likely to lead to new public safety limits. Some groups are actually recommending a relaxation of the existing (and inadequate) standards. Why is this happening? One reason is that exposure limits for ELF and RF are developed by bodies of scientists and engineers that belong to professional societies who have traditionally developed recommendations; and then government agencies have adopted those recommendations. The standard-setting processes have little, if any, input from other stakeholders outside professional engineering and closely-related commercial interests. Often, the industry view of allowable risk and proof of harm is most influential, rather than what public health experts would determine is acceptable.

Main Reasons for Disagreement among Experts

1) Scientists and public health policy experts use very different definitions of the standard of evidence used to judge the science, so they come to different conclusions about what to do. Scientists do have a role, but it is not exclusive and other opinions matter.
2) We are all talking about essentially the same scientific studies, but use a different way of measuring when "enough is enough" or "proof exists".
3) Some experts keep saying that all studies have to be consistent (turn out the same way every time) before they are comfortable saying an effect exists.
4) Some experts think that it is enough to look only at short-term, acute effects.
5) Other experts say that it is imperative we have studies over longer time (showing the effects of chronic exposures) since that is what kind of world we live in.
6) Some experts say that everyone, including the very young, the elderly, pregnant women, and people with illnesses have to be considered – others say only the average person (or in the case of RF, a six-foot tall man) matter.
7) There is no unexposed population, making it harder to see increased risk of diseases.
8) The lack of consensus about a single biological mechanism of action.
9) The strength of human epidemiological studies reporting risks from ELF and RF exposures, but animal studies don't show a strong toxic effect.
10) Vested interests have a substantial influence on the health debate.

Public Policy Decisions

Safety limits for public exposure to EMFs need to be developed on the basis of interaction among not only scientists, but also public health experts, public policy makers and the general public.

"In principle, the assessment of the evidence should combine with judgment based on other societal values, for example, costs and benefits, acceptability of risks, cultural preferences, etc. and result in sound and effective decision-making. Decisions on these matters are eventually taken as a function of the views, values and interests of the stakeholders participating in the process, whose opinions are then weighed depending on several factors. Scientific evidence perhaps carries, or should carry, relatively heavy weight, but grants no exclusive status; decisions will be evidence-based but will also be based on other factors." (1)

The clear consensus of the BioInitiative Working Group members is that the existing public safety limits are inadequate for both ELF and RF.

These proposals reflect the evidence that a positive assertion of safety with respect to chronic exposure to low-intensity levels of ELF and RF cannot be made. As with many other standards for environmental exposures, these proposed limits may not be totally protective, but more stringent standards are not realistic at the present time. Even a small increased risk for cancer and neurodegenerative diseases translates into an enormous public health consequence. Regulatory action for ELF and preventative actions for RF are warranted at this time to reduce exposures and inform the public of the potential for increased risk; at what levels of chronic exposure these risks may be present; and what measures may be taken to reduce risks.

C. Problems with Existing Public Health Standards (Safety Limits)

Today's public exposure limits for telecommunications are based on the presumption that heating of tissue (for RF) or induced electric currents in the body (for ELF) are the only concerns when living organisms are exposed to RF. These exposures can create tissue heating that is well known to be harmful in even very short-term doses. As such, thermal limits do serve a purpose. For example, for people whose occupations require them to work around radar facilities or RF heat-sealers, or for people who install and service wireless antenna tower, thermally-based limits are necessary to prevent damage from heating (or, in the case of power-frequency ELF from induced current flow in tissues). In the past, scientists and engineers developed exposure standards for electromagnetic radiation based what we now believe are faulty assumptions that the right way to measure how much non-ionizing energy humans can tolerate (how much exposure) without harm is to measure only the heating of tissue (RF) or induced currents in the body (ELF).

In the last few decades, it has been established beyond any reasonable doubt that bioeffects and some adverse health effects occur at far lower levels of RF and ELF exposure where no heating (or induced currents) occurs at all; some effects are shown to occur at several hundred thousand times below the existing public safety limits where heating is an impossibility.

It appears it is the INFORMATION conveyed by electromagnetic radiation (rather than heat) that causes biological changes - some of these biological changes may lead to loss of wellbeing, disease and even death.

Effects occur at non-thermal or low-intensity exposure levels thousands of times below the levels that federal agencies say should keep the public safe. For many new devices operating with wireless technologies, the devices are exempt from any regulatory standards. The existing standards have been proven to be inadequate to control against harm from low-intensity, chronic exposures, based on any reasonable, independent assessment of the scientific literature. It means that an entirely new basis (a biological basis) for new exposure standards is needed. New standards need to take into account what we have learned about the effects of ELF and RF (all non-ionizing electromagnetic radiation and to design new limits based on biologically-demonstrated effects that are important to proper biological function in living organisms. It is vital to do so because the explosion of new sources has created unprecedented levels of artificial electromagnetic fields that now cover all but remote areas of the habitable space on earth. Mid-course corrections are needed in the way we accept, test and deploy new technologies that expose us to ELF and RF in order to avert public health problems of a global nature.

Recent opinions by experts have documented deficiencies in current exposure standards. There is widespread discussion that thermal limits are outdated, and that biologically-based exposure standards are needed. Section 4 describes concerns expressed by WHO, 2007 in its ELF Health Criteria Monograph; the SCENIHR Report, 2006 prepared for the European Commission; the UK SAGE Report, 2007; the Health Protection Agency, United Kingdom in 2005; the NATO Advanced Research Workshop in 2005; the US Radiofrequency Interagency Working Group in 1999; the US Food and Drug Administration in 2000 and 2007; the World Health Organization in 2002; the International Agency for Cancer Research (IARC, 2001), the United Kingdom Parliament Independent Expert Group Report on Mobile Phones – Stewart Report, 2000) and others.

A pioneer researcher, the late Dr. Ross Adey, in his last publication in Bioelectromagnetic Medicine (P. Roche and M. Markov, eds. 2004) concluded:

> *"There are major unanswered questions about possible health risks that may arise from exposures to various man-made electromagnetic fields where these human exposures are intermittent, recurrent, and may extend over a significant portion of the lifetime of the individual."*
>
> *"Epidemiological studies have evaluated ELF and radiofrequency fields as possible risk factors for human health, with historical evidence relating rising risks of such factors as progressive rural electrification, and more recently, to methods of electrical power distribution and utilization in commercial buildings. Appropriate models describing these bioeffects are based in nonequilibrium thermodynamics, with nonlinear electrodynamics as an integral feature. Heating models, based in equilibrium thermodynamics, fail to explain an impressive new frontier of much greater significance. ..... Though incompletely understood, tissue free radical interactions with magnetic fields may extend to zero field levels." (2)*

There may be no lower limit at which exposures do not affect us. Until we know if there is a lower limit below which bioeffects and adverse health impacts do not occur, it is unwise from a public health perspective to continue "business-as-usual" deploying new technologies that increase ELF and RF exposures, particularly involuntary exposures.

II. SUMMARY OF THE SCIENCE

A. Evidence for Cancer

1. Childhood Leukemia

The evidence that power lines and other sources of ELF are consistently associated with higher rates of childhood leukemia has resulted in the International Agency for Cancer Research (an arm of the World Health Organization) to classify ELF as a Possible Human Carcinogen (in the Group 2B carcinogen list). Leukemia is the most common type of cancer in children.

There is little doubt that exposure to ELF causes childhood leukemia.

The exposure levels for increased risk are quite low – just above background or ambient levels and much lower than current exposure limits. The existing ICNIRP limit is 1000 mG (904 mG in the US) for ELF. Increased risk for childhood leukemia starts at levels almost one thousand times below the safety standard. Leukemia risks for young boys are reported in one study to double at only 1.4 mG and above (7) Most other studies combine older children with younger children (0 to 16 years) so that risk levels do not reach statistical significance until exposure levels reach 2 mG or 3 mG. Although some reviews have combined studies of childhood leukemia in ways that indicate the risk level starts at 4 mG and above; this does not reflect many of the studies reporting elevated risks at the lower exposure levels of 2 mG and 3 mG.

2. Other Childhood Cancers

Other childhood cancers have been studied, including brain tumors, but not enough work has been done to know if there are risks, how high these risks might be or what exposure levels might be associated with increased risks. The lack of certainty about other childhood cancers should not be taken to signal the "all clear"; rather it is a lack of study.

The World Health Organization ELF Health Criteria Monograph No 322 (2007) says that other childhood cancers "cannot be ruled out". (8)

There is some evidence that other childhood cancers may be related to ELF exposure but not enough studies have been done.

Several recent studies provide even stronger evidence that ELF is a risk factor for childhood leukemia and cancers later in life. In the first study (9), children who were recovering in high-

ELF environments had poorer survival rates (a 450% increased risk of dying if the ELF fields were 3 mG and above). In the second study, children who were recovering in 2 mG and above ELF environments were 300% more likely to die than children exposed to 1 mG and below. In this second study, children recovering in ELF environments between 1 and 2 mG also had poorer survival rates, where the increased risk of dying was 280%. (10) These two studies give powerful new information that ELF exposures in children can be harmful at levels above even 1 mG. The third study looked what risks for cancer a child would have later in life, if that child was raised in a home within 300 meters of a high-voltage electric power line. (11) For children who were raised for their first five years of life within 300 meters, they have a life-time risk that is 500% higher for developing some kinds of cancers.

Children who have leukemia and are in recovery have poorer survival rates if their ELF exposure at home (or where they are recovering) is between 1mG and 2 mG in one study; over 3 mG in another study.

Given the extensive study of childhood leukemia risks associated with ELF, and the relatively consistent findings that exposures in the 2 mG to 4 mG range are associated with increased risk to children, a 1 mG limit for habitable space is recommended for new construction. While it is difficult and expensive to retrofit existing habitable space to a 1 mG level, and is also recommended as a desirable target for existing residences and places where children and pregnant women may spend prolonged periods of time.

New ELF public exposure limits are warranted at this time, given the existing scientific evidence and need for public health policy intervention and prevention.

3. Brain Tumors and Acoustic Neuromas

Radiofrequency radiation from cell phone and cordless phone exposure has been linked in more than one dozen studies to increased risk for brain tumors and/or acoustic neuromas (a tumor in the brain on a nerve related to our hearing).

People who have used a cell phone for ten years or more have higher rates of malignant brain tumor and acoustic neuromas. It is worse if the cell phone has been used primarily on one side of the head.

For brain tumors, people who have used a cell phone for 10 years or longer have a 20% increase in risk (when the cell phone is used on both sides of the head). For people who have used a cell phone for 10 years or longer predominantly on one side of the head, there is a 200% increased risk of a brain tumor. This information relies on the combined results of many brain tumor/cell phone studies taken together (a meta-analysis of studies).

People who have used a cordless phone for ten years or more have higher rates of malignant brain tumor and acoustic neuromas. It is worse if the cordless phone has been used primarily on one side of the head.

The risk of brain tumor (high-grade malignant glioma) from cordless phone use is 220% higher (both sides of the head). The risk from use of a cordless phone is 470% higher when used mostly on only one side of the head.

For acoustic neuromas, there is a 30% increased risk with cell phone use at ten years and longer; and a 240% increased risk of acoustic neuroma when the cell phone is used mainly on one side of the head. These risks are based on the combined results of several studies (a meta-analysis of studies).

For use of cordless phones, the increased risk of acoustic neuroma is three-fold higher (310%) when the phone is mainly used on one side of the head.

The current standard for exposure to the emissions of cell phones and cordless phones is not safe considering studies reporting long-term brain tumor and acoustic neuroma risks.

Other indications that radiofrequency radiation can cause brain tumors comes from exposures to low-level RF other than from cell phone or cordless phone use. Studies of people who are exposed in their work (occupational exposure) show higher brain tumor rates as well. Kheifets (1995) reported a 10% to 20% increased risk of brain cancer for those employed in electrical occupations. This meta-analysis surveyed 29 published studies of brain cancer in relation to occupational EMFs exposure or work in electrical occupations. (6). The evidence for a link between other sources of RF exposure like working at a job with EMFs exposure is consistent with a moderately elevated risk of developing brain tumors.

4. *Other Adult Cancers*

There are multiple studies that show statistically significant relationships between occupational exposure and leukemia in adults (see Chapter 11), in spite of major limitations in the exposure assessment. A very recent study by Lowenthal et al. (2007) investigated leukemia in adults in relation to residence near to high-voltage power lines. While they found elevated risk in all adults living near to the high voltage power lines, they found an OR of 3.23 (95% CI = 1.26-8.29) for individuals who spent the first 15 years of life within 300 m of the power line. This study provides support for two important conclusions: adult leukemia is also associated with EMF exposure, and exposure during childhood increases risk of adult disease.

A significant excess risk for adult brain tumors in electrical workers and those adults with occupational EMF exposure was reported in a meta-analysis (review of many individual studies) by Kheifets et al., (1995). This is about the same size risk for lung cancer and secondhand smoke (US DHHS, 2006). A total of 29 studies with populations from 12 countries were included in this meta-analysis. The relative risk was reported as 1.16 (CI = 1.08 – 1.24) or a 16% increased risk for all brain tumors. For gliomas, the risk estimate was reported to be 1.39 (1.07 – 1.82) or a 39% increased risk for those in electrical occupations. A second meta-analysis published by Kheifets et al., ((2001) added results of 9 new studies published after 1995. It reported a new pooled estimate (OR = 1.16, 1.08 – 1.01) that showed little change in the risk estimate overall from 1995.

The evidence for a relationship between exposure and breast cancer is relatively strong in men (Erren, 2001), and some (by no means all) studies show female breast cancer also to be elevated with increased exposure (see Chapter 12). Brain tumors and acoustic neuromas are more common in exposed persons (see Chapter 10). There is less published evidence on other cancers, but Charles et al. (2003) report that workers in the highest 10% category for EMF exposure were twice as likely to die of prostate cancer as those exposed at lower levels (OR 2.02, 95% CI = 1.34-3.04). Villeneuve et al. (2000) report statistically significant elevations of non-Hodgkin's lymphoma in electric utility workers in relation to EMF exposure, while Tynes et al. (2003) report elevated rates of malignant melanoma in persons living near to high voltage power lines. While these observations need replication, they suggest a relationship between exposure and cancer in adults beyond leukemia.

In total the scientific evidence for adult disease associated with EMF exposure is sufficiently strong for adult cancers that preventive steps are appropriate, even if not all reports have shown exactly the same positive relationship. This is especially true since many factors reduce our ability to see disease patterns that might be related to EMF exposure: there is no unexposed population for comparison, for example, and other difficulties in exposure assessment, The evidence for a relationship between EMF exposure and adult cancers and neurodegenerative diseases is sufficiently strong at present to merit preventive actions to reduce EMF exposure.

5. *Breast Cancer*

There is rather strong evidence from multiple areas of scientific investigation that ELF is related to breast cancer. Over the last two decades there have been numerous epidemiological studies (studies of human illness) on breast cancer in both men and women, although this relationship remains controversial among scientists. Many of these studies report that ELF exposures are related to increased risk of breast cancer (not all studies report such effects, but then, we do not expect 100% or even 50% consistency in results in science, and do not require it to take reasonable preventative action).

The evidence from studies on women in the workplace rather strongly suggests that ELF is a risk factor for breast cancer for women with long-term exposures of 10 mG and higher.

Breast cancer studies of people who work in relatively high ELF exposures (10 mG and above) show higher rates of this disease. Most studies of workers who are exposed to ELF have defined high exposure levels to be somewhere between 2 mG and 10 mG; however this kind of mixing of relatively low to relatively high ELF exposure just acts to dilute out real risk levels. Many of the occupational studies group exposures so that the highest group is exposed to 4 mG and above. What this means is that a) few people are exposed to much higher levels and b) illness patterns show up at relatively low ELF levels of 4 mG and above. This is another way of demonstrating that existing ELF limits that are set at 933-1000 mG are irrelevant to the exposure levels reporting increased risks.

Laboratory studies that examine human breast cancer cells have shown that ELF exposure between 6 mG and 12 mG can interfere with protective effects of melatonin that fights the growth of these breast cancer cells. For a decade, there has been evidence that human breast cancer cells grow faster if exposed to ELF at low environmental levels. This is thought to be because ELF exposure can reduce melatonin levels in the body. The presence of melatonin in breast cancer cell cultures is known to reduce the growth of cancer cells. The absence of melatonin (because of ELF exposure or other reasons) is known to result in more cancer cell growth.

Laboratory studies of animals that have breast cancer tumors have been shown to have more tumors and larger tumors when exposed to ELF and a chemical tumor promoter at the same time. These studies taken together indicate that ELF is a likely risk factor for breast cancer, and that ELF levels of importance are no higher than many people are exposed to at home and at work. A reasonable suspicion of risk exists and is sufficient evidence on which to recommend new ELF limits; and to warrant preventative action.

Given the very high lifetime risks for developing breast cancer, and the critical importance of prevention; ELF exposures should be reduced for all people who are in high ELF environments for prolonged periods of time.

Reducing ELF exposure is particularly important for people who have breast cancer. The recovery environment should have low ELF levels given the evidence for poorer survival rates for childhood leukemia patients in ELF fields over 2 mG or 3 mG. Preventative action for those who may be at higher risk for breast cancer is also warranted (particularly for those taking tamoxifen as a way to reduce the risk of getting breast cancer, since in addition to reducing the effectiveness of melatonin, ELF exposure may also reduce the effectiveness of tamoxifen at these same low exposure levels). There is no excuse for ignoring the substantial body of evidence we already have that supports an association between breast cancer and ELF exposure; waiting for conclusive evidence is untenable given the enormous costs and societal and personal burdens caused by this disease.

Studies of human breast cancer cells and some animal studies show that ELF is likely to be a risk factor for breast cancer. There is supporting evidence for a link between breast cancer and exposure to ELF that comes from cell and animal studies, as well as studies of human breast cancers.

These are just some of the cancer issues to discuss. It may be reasonable now to make the assumption that all cancers, and other disease endpoints might be related to, or worsened by exposures to EMFs (both ELF and RF).

If one or more cancers are related, why would not all cancer risks be at issue? It can no longer be said that the current state of knowledge rules out or precludes risks to human health. The enormous societal costs and impacts on human suffering by not dealing proactively with this issue require substantive public health policy actions; and actions of governmental agencies charged with the protection of public health to act on the basis of the evidence at hand.

B. Changes in the Nervous System and Brain Function

Exposure to electromagnetic fields has been studies in connection with Alzheimer's disease, motor neuron disease and Parkinson's disease. (4) These diseases all involve the death of specific neurons and may be classified as neurodegenerative diseases. There is evidence that high levels of amyloid beta are a risk factor for Alzheimer's disease, and exposure to ELF can increase this substance in the brain. There is considerable evidence that melatonin can protect the brain against damage leading to Alzheimer's disease, and also strong evidence that exposure to ELF can reduce melatonin levels. Thus it is hypothesized that one of the body's main protections against developing Alzheimer's disease (melatonin) is less available to the body when people are exposed to ELF. Prolonged exposure to ELF fields could alter calcium ($Ca2+$) levels in neurons and induce oxidative stress (4). It is also possible that prolonged exposure to ELF fields may stimulate neurons (particularly large motor neurons) into synchronous firing, leading to damage by the buildup of toxins.

Evidence for a relationship between exposure and the neurodegenerative diseases, Alzheimer's and amyotrophic lateral sclerosis (ALS), is strong and relatively consistent (see Chapter 12). While not every publication shows a statistically significant relationship between exposure and disease, ORs of 2.3 (95% CI = 1.0-5.1 in Qio et al., 2004), of 2.3 (95% CI = 1.6-3.3 in Feychting et al., 2003) and of 4.0 (95% CI = 1.4-11.7 in Hakansson et al., 2003) for Alzheimer's Disease, and of 3.1 (95% CI = 1.0-9.8 in Savitz et al., 1998) and 2.2 (95% CI = 1.0-4.7 in Hakansson et al., 2003) for ALS cannot be simply ignored.

Alzheimer's disease is a disease of the nervous system. There is strong evidence that long-term exposure to ELF is a risk factor for Alzheimer's disease.

Concern has also been raised that humans with epileptic disorders could be more susceptible to RF exposure. Low-level RF exposure may be a stressor based on similarities of neurological effects to other known stressors; low-level RF activates both endogenous opioids and other substances in the brain that function in a similar manner to psychoactive drug actions. Such effects in laboratory animals mimic the effects of drugs on the part of the brain that is involved in addiction.

Laboratory studies show that the nervous system of both humans and animals is sensitive to ELF and RF. Measurable changes in brain function and behavior occur at levels associated with new technologies including cell phone use. Exposing humans to cell phone radiation can change brainwave activity at levels as low as 0.1 watt per kilogram SAR (W/Kg)*** in comparison to the US allowable level of 1.6 W/Kg and the International Commission for Non-ionizing Radiation Protection (ICNIRP) allowable level of 2.0 W/Kg. It can affect memory and learning. It can affect normal brainwave activity. ELF and RF exposures at low levels are able to change behavior in animals.

There is little doubt that electromagnetic fields emitted by cell phones and cell phone use affect electrical activity of the brain.

Effects on brain function seem to depend in some cases on the mental load of the subject during exposure (the brain is less able to do two jobs well simultaneously when the same part of the brain is involved in both tasks). Some studies show that cell phone exposure speeds up the brain's activity level; but also that the efficiency and judgment of the brain are diminished at the same time. One study reported that teenage drivers had slowed responses when driving and exposed to cell phone radiation, comparable to response times of elderly people. Faster thinking does not necessarily mean better quality thinking.

Changes in the way in which the brain and nervous system react depend very much on the specific exposures. Most studies only look at short-term effects, so the long-term consequences of exposures are not known.

Factors that determine effects can depend on head shape and size, the location, size and shape of internal brain structures, thinness of the head and face, hydration of tissues, thickness of various tissues, dialectric constant of the tissues and so on. Age of the individual and state of health also appear to be important variables. Exposure conditions also greatly influence the outcome of studies, and can have opposite results depending on the conditions of exposure including frequency, waveform, orientation of exposure, duration of exposure, number of exposures, any pulse modulation of the signal, and when effects are measured (some responses to RF are delayed). There is large variability in the results of ELF and RF testing, which would be expected based on the large variability of factors that can influence test results. However, it is clearly demonstrated that under some conditions of exposure, the brain and nervous system functions of humans are altered. The consequence of long-term or prolonged exposures have not been thoroughly studied in either adults or in children.

The consequence of prolonged exposures to children, whose nervous systems continue to develop until late adolescence, is unknown at this time. This could have serious implications to adult health and functioning in society if years of exposure of the young to both ELF and RF result in diminished capacity for thinking, judgment, memory, learning, and control over behavior.

People who are chronically exposed to low-level wireless antenna emissions report symptoms such as problems in sleeping (insomnia), fatigue, headache, dizziness, grogginess, lack of concentration, memory problems, ringing in the ears (tinnitus), problems with balance and orientation, and difficulty in multi-tasking. In children, exposures to cell phone radiation have resulted in changes in brain oscillatory activity during some memory tasks. Although scientific studies as yet have not been able to confirm a cause-and-effect relationship; these complaints are widespread and the cause of significant public concern in some countries where wireless technologies are fairly mature and widely distributed (Sweden, Denmark, France, Germany, Italy, Switzerland, Austria, Greece, Israel). For example, the roll-out of the new 3rd Generation wireless phones (and related community-wide antenna RF emissions in the Netherlands) caused almost immediate public complaints of illness.(5)

Conflicting results from those few studies that have been conducted may be based on the difficulty in providing non-exposed environments for testing to compare to environments that are intentionally exposed. People traveling to laboratories for testing are pre-exposed to a multitude of RF and ELF exposures, so they may already be symptomatic prior to actual testing. Also complicating this is good evidence that RF exposures testing behavioral changes show delayed results; effects are observed after termination of RF exposure. This suggests a persistent change in the nervous system that may be evident only after time has passed, so is not observed during a short testing period.

The effects of long-term exposure to wireless technologies including emissions from cell phones and other personal devices, and from whole-body exposure to RF transmissions from cell towers and antennas is simply not known yet with certainty. However, the body of evidence at hand suggests that bioeffects and health impacts can and do occur at exquisitely low exposure levels: levels that can be thousands of times below public safety limits.

The evidence reasonably points to the potential for serious public health consequences (and economic costs), which will be of global concern with the widespread public use of, and exposure to such emissions. Even a small increase in disease incidence or functional loss of cognition related to new wireless exposures would have a large public health, societal and economic consequences. Epidemiological studies can report harm to health only after decades of exposure, and where large effects can be seen across "average" populations; so these early warnings of possible harm should be taken seriously now by decision-makers.

C. Effects on Genes (DNA)

Cancer risk is related to DNA damage, which alters the genetic blueprint for growth and development. If DNA is damaged (the genes are damaged) there is a risk that these damaged cells will not die. Instead they will continue to reproduce themselves with damaged DNA, and this is one necessary pre-condition for cancer. Reduced DNA repair may also be an important part of this story. When the rate of damage to DNA exceeds the rate at which DNA can be repaired, there is the possibility of retaining mutations and initiating cancer. Studies on how ELF and RF may affect genes and DNA is important, because of the possible link to cancer.

Even ten years ago, most people believed that very weak ELF and RF fields could not possibly have any effect at all on DNA and how cells work (or are damaged and cannot do their work properly). The argument was that these weak fields are do not possess enough energy (are not physically strong enough) to cause damage. However, there are multiple ways we already know about where energy is not the key factor in causing damage. For example, exposure to toxic chemicals can cause damage. Changing the balance of delicate biological processes, including hormone balances in the body, can damage or destroy cells, and cause illness. In fact, many chronic diseases are directly related to this kind of damage that does not require any heating at all. Interference with cell communication (how cells interact) may either cause cancer directly or promote existing cancers to grow faster.

Using modern gene-testing techniques will probably give very useful information in the future about how EMFs targets and affects molecules in the body. At the gene level, there is some evidence now that EMFs (both ELF and RF) can cause changes in how DNA works. Laboratory studies have been conducted to see whether (and how) weak EMFs fields can affect how genes and proteins function. Such changes have been seen in some, but not all studies.

Small changes in protein or gene expression might be able to alter cell physiology, and might be able to cause later effects on health and well-being. The study of genes, proteins and EMFs is still in its infancy, however, by having some confirmation at the gene level and protein level that weak EMFs exposures do register changes may be an important step in establishing what risks to health can occur.

What is remarkable about studies on DNA, genes and proteins and EMFs is that there should be no effect at all if it were true that EMFs is too weak to cause damage. Scientists who believe that the energy of EMFs is insignificant and unlikely to cause harm have a hard time explaining these changes, so are inclined to just ignore them. The trouble with this view is that the effects are occurring. Not being able to explain these effects is not a good reason to consider them imaginary or unimportant.

The European research program (REFLEX) documented many changes in normal biological functioning in tests on DNA (3). The significance of these results is that such effects are directly related to the question of whether human health risks might occur, when these changes in genes and DNA happen. This large research effort produced information on EMFs effects from more than a dozen different researchers. Some of the key findings included:

> *"Gene mutations, cell proliferation and apoptosis are caused by or result in altered gene and protein expression profiles. The convergence of these events is required for the development of all chronic diseases."* (3)
>
> *"Genotoxic effects and a modified expression of numerous genes and proteins after EMF exposure could be demonstrated with great certainty."* (3)
>
> *"RF-EMF produced genotoxic effects in fibroblasts, HL-60 cells, granulosa cells of rats and neural progenitor cells derived from mouse embryonic stem cells."* (Participants 2, 3 and 4). (3)
>
> *"Cells responded to RF exposure between SAR levels of 0.3 and 2 W/Kg with a significant increase in single- and double-strand DNA breaks and in micronuclei frequency."* (Participants 2, 3 and 4). (3)

"In HL-60 cells an increase in intracellular generation of free radicals accompanying RF-EMF exposure could clearly be demonstrated." (Participant 2). (3)

"The induced DNA damage was not based on thermal effects and arouses consideration about the environmental safety limits for ELF-EMF exposure." (3)

"The effects were clearly more pronounced in cells from older donors, which could point to an age-related decrease of DNA repair efficiency of ELF-EMF induced DNA strand breaks." (3)

Both ELF and RF exposures can be considered genotoxic (will damage DNA) under certain conditions of exposure, including exposure levels that are lower than existing safety limits.

D. Effects on Stress Proteins (Heat Shock Proteins)

In nearly every living organism, there is a special protection launched by cells when they are under attack from environmental toxins or adverse environmental conditions. This is called a stress response, and what are produced are stress proteins (also known as heat shock proteins). Plants, animals and bacteria all produce stress proteins to survive environmental stressors like high temperatures, lack of oxygen, heavy metal poisoning, and oxidative stress (a cause of premature aging). We can now add ELF and RF exposures to this list of environmental stressors that cause a physiological stress response.

Very low-level ELF and RF exposures can cause cells to produce stress proteins, meaning that the cell recognizes ELF and RF exposures as harmful. This is another important way in which scientists have documented that ELF and RF exposures can be harmful, and it happens at levels far below the existing public safety standards.

An additional concern is that if the stress goes on too long, the protective effect is diminished. There is a reduced response if the stress goes on too long, and the protective effect is reduced. This means the cell is less protected against damage, and it is why prolonged or chronic exposures may be quite harmful, even at very low intensities.

The biochemical pathway that is activated is the same for ELF and for RF exposures, and it is non-thermal (does not require heating or induced electrical currents, and thus the safety standards based on protection from heating are irrelevant and not protective). ELF exposure levels of only 5 to 10 mG have been shown to activate the stress response genes (Table 2, Section 6). The specific absorption rate or SAR is not the appropriate measure of biological threshold or dose, and should not be used as the basis for a safety standard, since SAR only regulates against thermal damage.

E. Effects on the Immune System

The immune system is another defense we have against invading organisms (viruses, bacteria, and other foreign molecules). It protects us against illness, infectious diseases, and tumor cells. There are many different kinds of immune cells; each type of cell has a particular purpose, and is launched to defend the body against different kinds of exposures that the body determines might be harmful.

There is substantial evidence that ELF and RF can cause inflammatory reactions, allergy reactions and change normal immune function at levels allowed by current public safety standards.

The body's immune defense system senses danger from ELF and RF exposures, and targets an immune defense against these fields, much like the body's reaction in producing stress proteins. These are additional indicators that very low intensity ELF and RF exposures are a) recognized by cells and b) can cause reactions as if the exposure is harmful. Chronic exposure to factors that increase allergic and inflammatory responses on a continuing basis are likely to be harmful to health. Chronic inflammatory responses can lead to cellular, tissue and organ damage over time. Many chronic diseases are thought to be related to chronic problems with immune system function.

The release of inflammatory substances, such as histamine, are well-known to cause skin reactions, swelling, allergic hypersensitivity and other conditions that are normally associated with some kind of defense mechanism. The human immune system is part of a general defense barrier that protects against harmful exposures from the surrounding environment. When the immune system is aggravated by some kind of attack, there are many kinds of immune cells that can respond. Anything that triggers an immune response should be carefully evaluated, since chronic stimulation of the immune system may over time impair the system's ability to respond in the normal fashion.

Measurable physiological changes (mast cell increases in the skin, for example that are markers of allergic response and inflammatory cell response) are triggered by ELF and RF at very low intensities. Mast cells, when activated by ELF or RF, will break (degranulate) and release irritating chemicals that cause the symptoms of allergic skin reactions.

There is very clear evidence that exposures to ELF and RF at levels associated with cell phone use, computers, video display terminals, televisions, and other sources can cause these skin reactions. Changes in skin sensitivity have been measured by skin biopsy, and the findings are remarkable. Some of these reactions happen at levels equivalent to those of wireless technologies in daily life. Mast cells are also found in the brain and heart, perhaps targets of immune response by cells responding to ELF and RF exposures, and this might account for some of the other symptoms commonly reported (headache, sensitivity to light, heart arrythmias and other cardiac symptoms). Chronic provocation by exposure to ELF and RF can lead to immune dysfunction, chronic allergic responses, inflammatory diseases and ill health if they occur on a continuing basis over time.

These clinical findings may account for reports of persons with electrical hypersensitivity, which is a condition where there is intolerance for any level of exposure to ELF and/or RF. Although there is not yet a substantial scientific assessment (under controlled conditions, if that is even possible); anecdotal reports from many countries show that estimates range from 3% to perhaps 5% of populations, and it is a growing problem. Electrical hypersensitivity, like multiple chemical sensitivity, can be disabling and require the affected person to make drastic changes in work and living circumstances, and suffer large economic losses and loss of personal freedom. In Sweden, electrohypersensitivity (EHS) is officially recognized as fully functional impairment (i.e., it is not regarded as a disease – see Section 6, Appendix A).

F. Plausible Biological Mechanisms

Plausible biological mechanisms are already identified that can reasonably account for most biological effects reported for exposure to RF and ELF at low-intensity levels (oxidative stress and DNA damage from free radicals leading to genotoxicity; molecular mechanisms at very low energies are plausible links to disease, e.g., effect on electron transfer rates linked to oxidative damage, DNA activation linked to abnormal biosynthesis and mutation). It is also important to remember that traditional public health and epidemiological determinations do not require a proven mechanism before inferring a causal link between EMFs exposure and disease (12). Many times, proof of mechanism is not known before wise public health responses are implemented.

"Obviously, melatonin's ability to protect DNA from oxidative damage has implications for many types of cancer, including leukemia, considering that DNA damage due to free radicals is believed to be the initial oncostatic event in a majority of human cancers [Cerutti et al., 1994]. In addition to cancer, free radical damage to the central nervous system is a significant component of a variety of neurodegenerative diseases of the aged including Alzheimer's disease and Parkinsonism. In experimental animal models of both of these conditions, melatonin has proven highly effective in forestalling their onset, and reducing their severity [Reiter et al., 2001]." (13)

Oxidative stress through the action of free radical damage to DNA is a plausible biological mechanism for cancer and diseases that involve damage from ELF to the central nervous system.

G. Another Way of Looking at EMFs: Therapeutic Uses

Many people are surprised to learn that certain kinds of EMFs treatments actually can heal. These are medical treatments that use EMFs in specific ways to help in healing bone fractures, to heal wounds to the skin and underlying tissues, to reduce pain and swelling, and for other post-surgical needs. Some forms of EMFs exposure are used to treat depression.

EMFs have been shown to be effective in treating conditions of disease at energy levels far below current public exposure standards. This leads to the obvious question. How can scientists dispute the harmful effects of EMF exposures while at the same time using forms of EMF treatment that are proven to heal the body?

Medical conditions are successfully treated using EMFs at levels below current public safety standards, proving another way that the body recognizes and responds to low-intensity EMF signals. Otherwise, these medical treatments could not work. The FDA has approved EMFs medical treatment devices, so is clearly aware of this paradox.

Random exposures to EMFs, as opposed to EMFs exposures done with clinical oversight, could lead to harm just like the unsupervised use of pharmaceutical drugs. This evidence forms a strong warning that indiscriminate EMF exposure is probably a bad idea.

No one would recommend that drugs used in medical treatments and prevention of disease be randomly given to the public, especially to children. Yet, random and involuntary exposures to EMFs occur all the time in daily life.

The consequence of multiple sources of EMFs exposures in daily life, with no regard to cumulative exposures or to potentially harmful combinations of EMFs exposures means several things. First, it makes it very difficult to do clinical studies because it is almost impossible to find anyone who is not already exposed. Second, people with and without diseases have multiple and overlapping exposures – this will vary from person to person.

Just as ionizing radiation can be used to effectively diagnose disease and treat cancer, it is also a cause of cancer under different exposure conditions. Since EMFs are both a cause of disease, and also used for treatment of disease, it is vitally important that public exposure standards reflect our current understanding of the biological potency of EMF exposures, and develop both new public safety limits and measures to prevent future exposures.

III. EMF EXPOSURE AND PRUDENT PUBLIC HEALTH PLANNING

- **The scientific evidence is sufficient to warrant regulatory action for ELF; and it is substantial enough to warrant preventative actions for RF.**
- **The standard of evidence for judging the emerging scientific evidence necessary to take action should be proportionate to the impacts on health and well-being**
- **The exposures are widespread.**
- **Widely accepted standards for judging the science are used in this assessment.**

Public exposure to electromagnetic radiation (power-line frequencies, radiofrequency and microwave) is growing exponentially worldwide. There is a rapid increase in electrification in developing countries, even in rural areas. Most members of society now have and use cordless phones, cellular phones, and pagers. In addition, most populations are also exposed to antennas in communities designed to transmit wireless RF signals. Some developing countries have even given up running land lines because of expense and the easy access to cell phones. Long-term and cumulative exposure to such massively increased RF has no precedent in human history. Furthermore, the most pronounced change is for children, who now routinely spend hours each day on the cell phone. Everyone is exposed to a greater or lesser extent. No one can avoid exposure, since even if they live on a mountain-top without electricity there will likely be exposure to communication-frequency RF exposure. Vulnerable populations (pregnant women, very young children, elderly persons, the poor) are exposed to the same degree as the general population. Therefore it is imperative to consider ways in which to evaluate risk and reduce exposure. Good public health policy requires preventative action proportionate to the potential risk of harm and the public health consequence of taking no action.

IV. RECOMMENDED ACTIONS

A. Defining new exposure standards for ELF

This chapter concludes that new ELF limits are warranted based on a public health analysis of the overall existing scientific evidence. The public health view is that new ELF limits are needed now. They should reflect environmental levels of ELF that have been demonstrated to increase risk for childhood leukemia, and possibly other cancers and neurological diseases. ELF limits should be set below those exposure levels that have been linked in childhood leukemia studies to increased risk of disease, plus an additional safety factor. It is no longer acceptable to build new power lines and electrical facilities that place people in ELF environments that have been determined to be risky. These levels are in the 2 to 4 milligauss* (mG) range, not in the 10s of mG or 100s of mG. The existing ICNIRP limit is 1000 mG (904 mG in the US) for ELF is outdated and based on faulty assumptions. These limits are can no longer be said to be protective of public health and they should be replaced. A safety buffer or safety factor should also be applied to a new, biologically-based ELF limit, and the conventional approach is to add a safety factor lower than the risk level.

While new ELF limits are being developed and implemented, a reasonable approach would be a 1 mG planning limit for habitable space adjacent to all new or upgraded power lines and a 2 mG limit for all other new construction. It is also recommended for that a 1 mG limit be established for existing habitable space for children and/or women who are pregnant (because of the possible link between childhood leukemia and *in utero* exposure to ELF). This recommendation is based on the assumption that a higher burden of protection is required for children who cannot protect themselves, and who are at risk for childhood leukemia at rates that are traditionally high enough to trigger regulatory action. This situation in particular warrants extending the 1 mG limit to existing occupied space. "Establish" in this case probably means formal public advisories from relevant health agencies. While it is not realistic to reconstruct all existing electrical distribution systems, in the short term; steps to reduce exposure from these existing systems need to be initiated, especially in places where children spend time, and should be encouraged. These limits should reflect the exposures that are commonly associated with increased risk of child hood leukemia (in the 2 to 5 mG range for all children, and over 1.4 mG for children age 6 and younger). Nearly all of the occupational studies for adult cancers and neurological diseases report their highest exposure category is 4 mG and above, so that new ELF limits should target the exposure ranges of interest, and not necessarily higher ranges.

Avoiding chronic ELF exposure in schools, homes and the workplace above levels associated with increased risk of disease will also avoid most of the possible bioactive parameters of ELF discussed in the relevant literature.

B. Defining preventative actions for reduction in RF exposures

Given the scientific evidence at hand (Chapter 17), the rapid deployment of new wireless technologies that chronically expose people to pulsed RF at levels reported to cause bioeffects, which in turn, could reasonably be presumed to lead to serious health impacts, is of public health concern. Section 17 summarizes evidence that has resulted in a public health recommendation that preventative action is warranted to reduce or minimize RF exposures to the public. There is suggestive to strongly suggestive evidence that RF exposures may cause changes in cell membrane function, cell communication, cell metabolism, activation of proto-oncogenes and can trigger the production of stress proteins at exposure levels below current regulatory limits. Resulting effects can include DNA breaks and chromosome aberrations, cell death including death of brain neurons, increased free radical production, activation of the endogenous opioid system, cell stress and premature aging, changes in brain function including memory loss, retarded learning, slower motor function and other performance impairment in children, headaches and fatigue, sleep disorders, neurodegenerative conditions, reduction in melatonin secretion and cancers (Chapters 5, 6, 7, 8, 9, 10, and 12).

As early as 2000, some experts in bioelectromagnetics promoted a 0.1 μW/cm2 limit (which is 0.614 Volts per meter) for ambient outdoor exposure to pulsed RF, so generally in cities, the public would have adequate protection against involuntary exposure to pulsed radiofrequency (e.g., from cell towers, and other wireless technologies). The Salzburg Resolution of 2000 set a target of 0.1 μW/cm2 (or 0.614 V/m) for public exposure to pulsed radiofrequency. Since then, there are many credible anecdotal reports of unwellness and illness in the vicinity of wireless transmitters (wireless voice and data communication antennas) at lower levels. Effects include sleep disruption, impairment of memory and concentration, fatigue, headache, skin disorders, visual symptoms (floaters), nausea, loss of appetite, tinnitus, and cardiac problems (racing heartbeat), There are some credible articles from researchers reporting that cell tower -level RF exposures (estimated to be between 0.01 and 0.5 μW/cm2) produce ill-effects in populations living up to several hundred meters from wireless antenna sites.

This information now argues for thresholds or guidelines that are substantially below current FCC and ICNIPR standards for whole body exposure. Uncertainty about how low such standards might have to go to be prudent from a public health standpoint should not prevent reasonable efforts to respond to the information at hand. No lower limit for bioeffects and adverse health effects from RF has been established, so the possible health risks of wireless WLAN and WI-FI systems, for example, will require further research and no assertion of safety at any level of wireless exposure (chronic exposure) can be made at this time. The lower limit for reported human health effects has dropped 100-fold below the safety standard (for mobile phones and PDAs); 1000- to 10,000-fold for other wireless (cell towers at distance; WI-FI and WLAN devices). The entire basis for safety standards is called into question, and it is not unreasonable to question the safety of RF at any level.

A cautionary target level for pulsed RF exposures for ambient wireless that could be applied to RF sources from cell tower antennas, WI-FI, WI-MAX and other similar sources is proposed. The recommended cautionary target level is 0.1 microwatts per centimeter squared (μW/cm2)** (or 0.614 Volts per meter or V/m)** for pulsed RF where these exposures affect the general public; this advisory is proportionate to the evidence and in accord with prudent public health policy. A precautionary limit of 0.1 μW/cm2 should be adopted for outdoor, cumulative RF exposure. This reflects the current RF science and prudent public health response that would reasonably be set for pulsed RF (ambient) exposures where people live, work and go to school. This level of RF is experienced as whole-body exposure, and can be a chronic exposure where there is wireless coverage present for voice and data transmission for cell phones, pagers and PDAs and other sources of radiofrequency radiation. An outdoor precautionary limit of 0.1 μW/cm2 would mean an even lower exposure level inside buildings, perhaps as low as 0.01 μW/cm2. Some studies and many anecdotal reports on ill health have been reported at lower levels than this; however, for the present time, it could prevent some of the most disproportionate burdens placed on the public nearest to such installations. Although this RF target level does not preclude further rollout of WI-FI technologies, we also recommend that wired alternatives to WI-FI be implemented, particularly in schools and libraries so that children are not subjected to elevated RF levels until more is understood about possible health impacts. This recommendation should be seen as an interim precautionary limit that is intended to guide preventative actions; and more conservative limits may be needed in the future.

Broadcast facilities that chronically expose nearby residents to elevated RF levels from AM, FM and television antenna transmission are also of public health concern given the potential for very high RF exposures near these facilities (antenna farms). RF levels can be in the 10s to several 100's of μW/cm2 in residential areas within half a mile of some broadcast sites (for example, Lookout Mountain, Colorado and Awbrey Butte, Bend, Oregon). Such facilities that are located in, or expose residential populations and schools to elevated levels of RF will very likely need to be re-evaluated for safety.

For emissions from wireless devices (cell phones, personal digital assistant or PDA devices, etc) there is enough evidence for increased risk of brain tumors and acoustic neuromas now to warrant intervention with respect to their use. Redesign of cell phones and PDAs could prevent direct head and eye exposure, for example, by designing new units so that they work only with a wired headset or on speakerphone mode.

These effects can reasonably be presumed to result in adverse health effects and disease with chronic and uncontrolled exposures, and children may be particularly vulnerable. The young are also largely unable to remove themselves from such environments. Second-hand radiation, like second-hand smoke is an issue of public health concern based on the evidence at hand.

V. CONCLUSIONS

- We cannot afford 'business as usual" any longer. It is time that planning for new power lines and for new homes, schools and other habitable spaces around them is done with routine provision for low-ELF environments . The business-as-usual deployment of new wireless technologies is likely to be risky and harder to change if society does not make some educated decisions about limits soon. Research must continue to define what levels of RF related to new wireless technologies are acceptable; but more research should not prevent or delay substantive changes today that might save money, lives and societal disruption tomorrow.

- New regulatory limits for ELF are warranted. ELF limits should be set below those exposure levels that have been linked in childhood leukemia studies to increased risk of disease, plus an additional safety factor. It is no longer acceptable to build new power lines and electrical facilities that place people in ELF environments that have been determined to be risky (at levels generally at 2 mG and above).

• While new ELF limits are being developed and implemented, a reasonable approach would be a 1 mG planning limit for habitable space adjacent to all new or upgraded power lines and a 2 mG limit for all other new construction, It is also recommended for that a 1 mG limit be established for existing habitable space for children and/or women who are pregnant. This recommendation is based on the assumption that a higher burden of protection is required for children who cannot protect themselves, and who are at risk for childhood leukemia at rates that are traditionally high enough to trigger regulatory action. This situation in particular warrants extending the 1 mG limit to existing occupied space. "Establish" in this case probably means formal public advisories from relevant health agencies.

• While it is not realistic to reconstruct all existing electrical distributions systems, in the short term; steps to reduce exposure from these existing systems need to be initiated, especially in places where children spend time, and should be encouraged.

• A precautionary limit of 0.1 (μW/cm2 (which is also 0.614 Volts per meter) should be adopted for outdoor, cumulative RF exposure. This reflects the current RF science and prudent public health response that would reasonably be set for pulsed RF (ambient) exposures where people live, work and go to school. This level of RF is experienced as whole-body exposure, and can be a chronic exposure where there is wireless coverage present for voice and data transmission for cell phones, pagers and PDAs and other sources of radiofrequency radiation. Some studies and many anecdotal reports on ill health have been reported at lower levels than this; however, for the present time, it could prevent some of the most disproportionate burdens placed on the public nearest to such installations. Although this RF target level does not preclude further rollout of WI-FI technologies, we also recommend that wired alternatives to WI-FI be implemented, particularly in schools and libraries so that children are not subjected to elevated RF levels until more is understood about possible health impacts. This recommendation should be seen as an interim precautionary limit that is intended to guide preventative actions; and more conservative limits may be needed in the future.

VI. References

1. Martuzzi M. 2005. Science, Policy and the Protectoin of Human Health: A European Perspective. Bioelectromagnetics Supplement 7: S151-156.

2. Adey, WR. Potential Therapeutic Applications of Nonthermal Electromagnetic Fields: Ensemble Organization of Cells in Tissue as a Factor in Biological Field Sensing. Bioelectromagnetic Medicine. 2004, Rosch PJ and Markov MS, editors, page 1.

(3) REFLEX, 2004. Risk Evaluation of Potential Environmental Hazards from Low Frequency Electromagnetic Field Exposure Using Sensitive *in vitro* Methods.

(4) World Health Organization, 2007. ELF Health Criteria Monograph. Neurodegenerative Disorders, Page 187.

(5) TNO Physics and Electronics Laboratory, The Netherlands. 2003. Effects of Global Communication System radio-frequency fields on well-being and cognitive functions of human beings with and without subjective complaints. Netherlands Organization for Applied Scientific Research 1-63.

(6) Kheifets LI Afifi AA Buffler PA Zhang ZW. 1995. Occupational electric and magnetic field exposure and brain cancer: a meta-analysis. JOEM Vol 37, No. 2, 1327 – 1341.

(7) Green LM, Miller AB, Villeneuve PJ, Agnew DA, Greenberg ML, Li J, Donnelly KE. 1999. A case-control study of childhood leukemia in southern Ontario Canada and exposure to magnetic fields in residences. Int J Cancer 82: 161–170.

(8) World Health Organization, 2007. ELF Health Criteria Monograph, page 256 and WHO Fact Sheet No. 322.

(9) Foliart DE Pollock BH Mezei G Iriye R Silva JM Epi KL Kheifets L Lind MP Kavet R. 2006. Magnetic field exposure and long-term survival among children with leukemia. British Journal of Cancer 94 161-164.

(10) Svendsen AL Weihkopf T Kaatsch P Schuz J. 2007. Exposure to magnetic fields and survival after diagnosis of childhood leukemia: a German cohort study. Cancer Epidemiol Biomarkers Prev 16(6) 1167-1171.

(11) Lowenthal RM, Tuck DM and Bray IC (2007) Residential exposure to electric power transmission lines and risk of lymphoproliferative and myeloproliferative disorders: a case-control study. Int Med J doi:10.1111/j.1445-5994.2007.01389.x

(12) Hill, AB. 1971. Principles of Medical Statistics Chapter XXIV. Statistical Evidence and Inference, Oxford University Press, Oxford University, Oxford, UK, p. 309-323.

(13)) Henshaw DL Reiter RJ. 2005. Do magnetic fields cause increased risk of childhood leukemia via melatonin disruption? A Review. Bioelectromagnetics Supplement 7, pages S86-S97.

Some Quick Definitions for Units of Measurement of ELF and RF

<u>*Milligauss (mG)</u>

A milligauss is a measure of ELF intensity and is abbreviated mG. This is used to describe electromagnetic fields from appliances, power lines, interior electrical wiring.

****Microwatts per centimeter squared (µW/cm2)**

Radiofrequency radiation in terms of power density is measured in microwatts per centimeter squared and abbreviated (µW/cm2). It is used when talking about emissions from wireless facilities, and when describing ambient RF in the environment. The amount of allowable RF near a cell tower is 1000 µW/cm2 for some cell phone frequencies, for example.

*****Specific Absorption Rate (SAR is measured in watts per kilogram or W/Kg)**

SAR stands for specific absorption rate. It is a calculation of how much RF energy is absorbed into the body, for example when a cell phone or cordless phone is pressed to the head. SAR is expressed in watts per kilogram of tissue (W/Kg). The amount of allowable energy into 1 gram of brain tissue from a cell phone is 1.6 W/Kg in the US. For whole body exposure, the exposure is 0.8 W/Kg averaged over 30 minutes for the general public. International standards in most countries are similar, but not exactly the same.

EXHIBIT
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SECTION 17

KEY SCIENTIFIC EVIDENCE AND PUBLIC HEALTH POLICY RECOMMENDATIONS

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July 2007

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I. KEY SCIENTIFIC EVIDENCE

Exposure to electromagnetic fields (EMF) has been linked to a variety of adverse health outcomes. The health endpoints that have been reported to be associated with ELF and/or RF include childhood leukemia, adult brain tumors, childhood brain tumors, genotoxic effects (DNA damage and micronucleation), neurological effects and neurodegenerative disease, immune system disregulation, allergic and inflammatory responses, breast cancer in men and women, miscarriage and some cardiovascular effects. Effects are not specifically segregated for ELF or RF, since many overlapping exposures occur in daily life; and because this is an artificial division based on frequencies as defined in physics that has little bearing on the biological effects. Both ELF and RF, for example have been shown to cause cells to generate stress proteins, a universal sign of distress in plant, animal and human cells.

The number of people exposed to elevated levels of EMF has been estimated in various studies, and there is general agreement among them. In the United States, few people have chronic or prolonged exposures over 4 mG (0.4 μT) (Kheifets et al, 2005b). Section 20 has information on average residential and occupational ELF levels. The highest exposure category in most all studies is $\geq$ 4 mG ($\geq$ 0.4 μT). Many people have daily exposures to ELF in various ways, some of them up to several hundred milligauss for short periods of time, but relatively few people with the exception of some occupational workers habitually experience ELF exposures greater than 1-2 mG (0.2 – 0.3 μT - App. 20-A).

The exposure of children to EMF has not been studied extensively; in fact, the FCC standards for exposure to radiofrequency radiation are based on the height, weight and stature of a 6-foot tall man, not scaled to children or adults of smaller stature. They do not take into account the unique susceptibility of growing children to exposures

(SCENIHR, 2007; Jarosinska and Gee, 2007), nor are there studies of particular relevance to children.

Differences in exposure patterns between infants, children and adults; 2) special susceptibilities of infants and children to the effects of EMF; and 3) interactions between chemical contaminants and EMF are lacking; as are studies on chronic exposure for both children and adults. There is reason to believe that children may be more susceptible to the effects of EMF exposure since they are growing, their rate of cellular activity and division is more rapid, and they may be more at risk for DNA damage and subsequent cancers. Growth and development of the central nervous system is still occurring well into the teenage years so that neurological changes may be of great importance to normal development, cognition, learning, and behavior. Prenatal exposure to EMF have been identified as possible risk factor for childhood leukemia. Children are largely unable to remove themselves from exposures to harmful substances in their environments. Their exposure is involuntary.

Like second-hand smoke, EMF is a complex mixture, where different frequencies, intensities, durations of exposure(s), modulation, waveform and other factors is known to produce variable effects. Many years of scientific study has produced substantial evidence that EMF may be considered to be both carcinogenic and neurotoxic. The weight of evidence is discussed in this report, including epidemiological evidence and studies on laboratory animals.

Relative risk estimates associated with some of these endpoints are small and the disease is fairly rare (for childhood leukemia, for example), For other diseases, the risk estimates are small but the diseases are common and EMF exposures at levels associated with increased risks are widespread and chronic so the overall public health impacts may be very large.

A. Weight of Evidence Assessment and Criteria for Causality

A weight-of-evidence approach has been used to describe the body of evidence between health endpoints and exposure to electromagnetic fields (ELF and RF).

The number and quality of epidemiological studies, as well as other sources of data on biological plausibility are considered in making scientific and public health policy judgments. Methodological issues that were considered in the review of the epidemiological literature include 1) quality of exposure assessment. 2) sample size of the study, which detects the power to detect an effect, 3) extent to which the analysis or design takes into account potential confounders or other risk factors, 4) selection bias, 5) the potential for bias in determining exposure. Assessment of the epidemiological literature is consistent with guidelines from Hill (1971), Rothman and Greenland (1998) and the Surgeon General's Reports on Smoking (US DHHS, 2004), and California Air Resources Board (2005). Factors that were considered in reaching conclusions about the weight of evidence overall included strength of the association, consistency of association, temporality, biological plausibility, dose-response and issues with non-linear dose-response, specificity and experimental evidence.

There is a relatively large amount of human epidemiological information with real world exposures, including data from occupational studies. There is less animal data in most cases, except for the genotoxicity studies. Human epidemiological evidence has be given the greatest weight in making judgments about weight-of-evidence, where the results across high quality studies give relatively consistent positive results. Meta-analyses of childhood leukemia, adult leukemia, adult brain tumors, childhood brain tumors, male and female breast cancer and Alzheimer's disease were relied upon in assessing the overall strength of epidemiological study results. Sections 5 – 15 provide analysis of the relevant scientific studies that are key evidence in making public health policy recommendations with respect to exposure to electromagnetic fields (both ELF and RF).

B. Summary of Evidence

1. Childhood Leukemia

Several meta-analyses have been conducted to assess risks of childhood leukemia from exposure to ELF. The results of these studies that combine or pool results of many individual studies (including studies that report both effects and no effects) consistently report increased risks.

Meta-Analysis: Studies of Childhood Leukemia and EMF

Greenland et al., (2000) reported a significantly elevated risk of 1.68 [95% CI 1.23-2.31] based on pooled results from 12 studies using a time-weighted average of exposure greater than 3 mG (0.3 μT). This is a 68% increased risk of childhood leukemia.

Ahlbom et al., (2000) reported a doubling of risk based on a meta-analysis of nine (9) studies. The results reported an elevated risk of 2.0 [95% CI 1.27-3.13] for EMF exposures equal to or greater than 4 mG (0.4 μT) as compared to less than 1 mG (0.1 μT)

Other Relevant Evidence

In 2002, the International Agency for Cancer Research (IARC) designated EMF as a "possible human carcinogen" or Group 2B Carcinogen based on consistent epidemiological evidence. The exposure levels at which increased risks of childhood leukemia are reported in individual studies range from above 1.4 mG or 0.14 μT (Green et al., 1999).
for younger children to age six (6) to 4 mG (0.4 μT). Many individual studies with cutpoints of 2 mG or 3 mG (0.2-0.3 μT)) report increased risks. Plausible biological mechanisms exist that may reasonably account for a causal relationship between EMF exposure and childhood leukemia.

Recurrence of Childhood Leukemia and Poorer Survival Rates with Continued EMF Exposure

Foliart reported more than a four-fold (450% increased risk) of adverse outcome (poorer survival rate) for children with acute lymphoblastic leukemia (ALL) who were recovering in EMF environments of 3 mG (0.3 μT) and above (OR 4.5, CI 1.5-13.8). Svendsen reported a poorer survival rate of children with acute lymphoblastic leukemia (ALL) in children exposed to 2 mG (0.2 μT) and above. These children were three times more likely (300% increased risk) to die than children recovering in fields of less than 1 mG (OR 3.0, CI 0.9.8). Children recovering in EMF environments between 1- 2 mG (0.1-0.2 μT) also had poorer survival rates, where the increased risk was 280% (OR 2.8, CI 1.2-6.2).

Higher Lifetime Cancer Risks with Childhood EMF Exposure

Lowenthal (2007) reported that children raised for the first five years in home environments exposed to EMF within 300 meters of a high voltage power line have a five-fold (a 500 percent increased risk of developing some kinds of cancers sometime in later life. For children from newborn to 15 years of age; it is a three-fold risk of developing cancer later in life (Lowenthal et al., 2007). There is suggestive evidence for a link between adult leukemia and EMF exposure.

Attributable Risk

Wartenberg estimates that 8% to 11% of childhood leukemia cases may be related to ELF exposure. This translates into an additional 175 to 240 cases of childhood leukemia based on 2200 US cases per year. The worldwide total of annual childhood leukemias is estimated to be 49,000, giving an estimate of nearly 4000 to 5400 cases per year. Other researchers have estimated higher numbers that could reach to 80% of all cases (Milham, 2001).

2. Childhood Brain Tumors

Childhood Brain Tumors

There is suggestive evidence that other childhood cancers may be related to EMF exposure. The meta-analysis by Wartenberg et al., (1998) reported increased risks for childhood brain tumors. Risks are quite similar whether based on calculated EMF fields (OR = 1.4, 95% CI = 0.8 – 2.3] or based on measured EMF fields (OR = 1.4, 95% CI = 0.8 – 2.4).

3. Adult Brain Tumors

Brain Tumors in Electrical Workers and in Electrical Occupations (Meta-analysis)

A significant excess risk for adult brain tumors in electrical workers and those adults with occupational EMF exposure was reported (Kheifets et al., 1995). This is about the same size risk for lung cancer and second hand smoke (US DHHS, 2006). A total of 29 studies with populations from 12 countries were included in this meta-analysis. The relative risk was reported as 1.16 (CI = 1.08 – 1.24) or a 16% increased risk for all brain tumors. For gliomas, the risk estimate was reported to be 1.39 (1.07 – 1.82) or a 39% increased risk for those in electrical occupations. A second meta-analysis published by Kheifets et al., ((2001) added results of 9 new studies published after 1995. It reported a new pooled estimate (OR = 1.16, 1.08 – 1.01) that showed little change in the risk estimate overall from 1995.

4. Brain Tumors and Acoustic Neuromas in Cell Phone and Cordless Phone Users (Meta-Analysis)

Glioma and Acoustic Neuroma

Hardell et al., (2007) reported in a meta-analysis statistically significant increased risk for glioma with exposure of 10 years or greater in persons using cell phones. Risks were estimated to be 1.2 (0.8 – 1.9) for all use; but when ipsilateral use was assessed (mainly on same side of head) it increased the risk of glioma to 2.0 (1.2 – 3.4) for 10 years and greater use.

For acoustic neuromas, Hardell et al., (2007) reported the increased risk with 10 years or more of exposure to a cell phone at 1.3 (0.6 – 2.8) but this risk increased to 2.4 (1.1 – 5.3) with ipsilateral use (mainly on the same side of the head). There is a consistent pattern of increased risk for brain tumors (glioma) and acoustic neuromas at 10 years and greater exposure to cell phones.

The meta-analysis by Lakhola et al., (2006) reported that brain tumor risk was 1.3 (0.99 – 1.9) for ipsilateral use of a cell phone, but no data was given for exposures at 10 years or greater (all exposures were of shorter duration).

The meta-analysis by Kan et al., (2007) reported "no overall risk" but found elevated risk of brain tumors (RR = 1.25, CI 1.01 – 1.54) $\geq$ 10 years, reinforcing the findings of other pooled estimates of risk. No estimates of increased risk with ipsilateral use were provided, which would have likely increased reported risks.

5. Neurodegenerative Diseases

Alzheimer's Disease and ALS

Evidence for a relationship between exposure and the neurodegenerative diseases, Alzheimer's and amyotrophic lateral sclerosis (ALS), is strong and relatively consistent. While not every publication shows a statistically significant relationship between exposure and disease, ORs of 2.3 (95% CI = 1.0-5.1 in Qio et al., 2004), of 2.3 (95% CI = 1.6-3.3 in Feychting et al., 2003) and of 4.0 (95% CI = 1.4-11.7 in Hakansson et al., 2003) for Alzheimer's Disease.

Hakansson et al., report more than a doubling of risk for ALS 2.2 (95% CI = 1.0-4.7).

Savitz et al., (1998) reports more than a tripling of risk for ALS (3.1, CI = 1.0 – 9.8).

6. Breast Cancer (Men and Women)

A meta-analysis by Erren (2001) on EMF and breast cancer reported pooled relative risks based on studies of both men and women. A total of 38 publications were reviewed; there were 23 studies on men; 25 studies on women; and 10 studies on both men and women. The pooled relative risk for women exposed to EMF was 1.12 (CI 1.09 – 1.15) or a 12% increased risk, Erren observed that variations between the contributing results are not easily attributable to chance (P = 0.0365). For men and breast cancer, he reported a fairly homogeneous increased risk (a pooled relative risk of 1.37 [CI 1.11 – 1.71]).

This analysis is well conducted. The results were stratified according to measured or assumed intensity of exposure to EMF; and the estimate of risk for the most heavily exposed group was extracted. Independent estimates of RRs were grouped according to gender, type of study (case-control and cohort), country where the study was conducted and method used to assess exposure. Pooled estimates of RRs and their 95% confidence intervals (CI) referring to various combinations of these factors were calculated according to appropriate statistical methods (Greenland, 1987). Misclassification possibilities were thoroughly assessed, and whether the results were sole endpoints or there were multiple endpoints in each study did not affect the RRs.

Erren qualifies his findings by discussing that latencies for cancers can be 20 to 30 years, Further, he notes that studies of total EMF exposures from both home, travel and workplace are rarely available, and these EMF sources are ubiquitous. Both could result in underestimation of risks. Another way in which risks might be masked is by variations in age of study participants. Forssen and colleagues (2000) reported no increased RRs for breast cancer in women of all ages when they combined residential and occupational EMF exposures (RR = 0.9, CI 0.3 – 2.7). However, when risks for the women younger than 50 years of age were separated out and calculated, the RR increased to 7.3 (CI 0.7 – 78.3) although with wide confidence intervals based on only four cases. Erren notes

"When possibly relevant exposures to EMF in the whole environment are assessed only partially, errors in the categorization of exposure status are likely to occur. If such misclassification is random and thus similar in subrgroups being compared (nondifferential), then the error will tend to introduce bias towards the null. Substantial random misclassification of exposures would then tend to generate spurious reports of 'little or no effect'. Note for example that estimates of smoking-associated lung cancer risks in the early 1950's could have been seriously distorted if exposure assessment had not considered smoking either at work or at home."

"Collectively, the data are consistent with the idea that exposures to EMF, as defined, are associated with some increase in breast cancer risks, albeit the excess risk is small." Erren (2001)

7. Combined Effects of Toxic Agents and ELF

ELF and Toxic Chemical Exposures

There is also the issue of what weight to give the evidence for synergistic effects of toxic chemical exposure and EMF exposure. Juuilainen et al., (2006) reported that the combined effects of toxic agents and ELF magnetic fields together enhances damage as compared to the toxic exposure alone. In a meta-analysis of 65 studies; overall results showed 91% of the *in vivo* studies and 68% of the *in vitro* studies had worse outcomes (were positive for changes indicating synergistic damage) with ELF exposure in combination with toxic agents. The percentage of the 65 studies with positive effects was highest when the EMF exposure preceded the other exposure. The radical pair mechanism (oxidative damage due to free radicals) is cited as a good candidate to explain these results. Reconsideration of exposure limits for ELF is warranted based on this evidence.

II. FALLACIES AND ANSWERS IN THE DEBATE OVER EMF EVIDENCE

There are several arguments (false, in our view) that have been presented by those who minimize the strength of the relationship between exposure to both 50-60Hz ELF and RF EMFs. These are as follows:

A. "Only a small number of children are affected."

This argument is not correct because we do not know precisely how many children are affected. In 1988 Carpenter and Ahlbom attempted to answer this question based on the results of the New York State Powerlines Project and the results of the study of Savitz et al. (1988), and concluded that if the magnetic fields homes in the US were similar to those in Denver, Colorado fully 10 to 15% of US childhood leukemia (about 1,000 cases) could be associated with residential magnetic field exposure. They then concluded that exposure to magnetic fields from non-residential sources (particularly appliances) must be at least equal in magnitude, and that if so these two sources of exposure would account for 20-35% of childhood leukemia.

There have been several meta-analyses of the childhood leukemia data (Wartenberg, 1998; Greenland et al., 2000; Ahlbom et al., 2000). All have concluded that there is a significant association between residential exposure to magnetic fields and elevated risk of leukemia in children. Greenland et al. (2000)

performed a meta-analysis of 15 studies of magnetic field or wire code investigations of childhood leukemia, and calculated the attributable fraction of cases of childhood leukemia from residential magnetic field exposure in the US was 3%. Ahlbom et al. (2000) conducted a different meta-analysis that concluded there was a significant 2-fold elevation of risk at exposure levels of 4 mG (0.4 μT) or greater. Kheifets et al. (2006) attempted to calculate the attributable fraction of worldwide childhood leukemia due to EMFs, based on the meta-analyses of Ahlbom et al. (2000) and Greenland et al., (2000). They concluded that the attributable fraction of leukemia was between <1% to 4%. The recent WHO Environmental Health Criteria ELF Monograph #238 (2007) states "(A)ssuming that the association is causal, the number of cases of childhood leukaemia worldwide that might be attributable to exposure can be estimated to range from 100 to 2,400 cases per year. However this represents 0.2 to 4.9% of the total annual incidence of leukaemia cases, estimated to be 49,000 worldwide in 2000. Thus, in a global context, the impact on public health, if any, would be limited and uncertain."

These reports are important, in that they show consistency in there being a clearly elevated risk of leukemia in children with EMF exposure from power line fields in homes. These meta-analyses lead to the conclusion, reflected in the WHO report, that there is an association between childhood cancer and exposure to elevated magnetic fields in homes. We strongly disagree, however, with the overall conclusion that these calculations indicate that the fraction of childhood leukemia attributable to EMFs is so small as to not have serious public health implications.

There are several reasons why the WHO ELF Environmental Health Criteria Monograph conclusion is not justified. These studies all considered either only measured magnetic fields in homes or wire codes from power lines, ignoring exposure from appliances, wireless devices and all exposures outside of the home. Thus these metrics do not come close to accounting for any individual's cumulative exposure to EMFs. If residential magnetic fields cause cancer, then those from other sources will add to the risk. The failure to measure total EMF exposure would tend to obscure the relationship and lead to gross underestimation of the true relationship between exposure and disease. While the evidence for a relationship between exposure and childhood leukemia may be considered to be definitive at exposure levels of 3 or 4 mG (0.3 or 0.4 μT) or higher; there is evidence from some (but not all) of the other studies for an elevated risk at levels not greater than 2 mG (0.2 μT) (Savitz et al., 1988; Green, 1999). There is absolutely no evidence that exposures at lower levels are "safe", since persons with these exposures are usually the "control" group. Therefore this WHO statement fails to acknowledge the true magnitude of the problem, even when considering only childhood leukemia. The global attributable risk of childhood leukemia as a result of exposure to EMFs must be significantly greater than that calculated from consideration of only residential 50/60 Hz magnetic fields in studies where there is no unexposed control.

As detailed in other chapters in this report (Chapter 10), there is some evidence for a relationship between EMF exposure and brain cancers in children. We have almost no understanding of the mechanisms behind the development of brain cancers, and any cancer in a child is a tragedy. While evidence for a relationship between EMF exposure and childhood brain cancer is not as strong as for leukemia, it is of concern and deserves more study. Of even greater concern, given the clear evidence for elevated risk of childhood leukemia upon exposure to 50/60 Hz EMFs, is the relative lack of a comparable body of information on the effects of radiofrequency EMFs on the health of children. A recent study of South Korean children (1,928 with leukemia, 956 with brain cancer and 3,082 controls) living near to AM radio transmitters reports an OR of 2.15 (95% CI = 1.19-2.11) for risk of leukemia in children living within 2 km of the nearest AM transmitter as compared to those living more than 20 km from it (Ha et al., 2007). No relation was found for brain cancer. This study is consistent with the hypothesis that radiofrequency EMFs have similar effects to 50/60 Hz EMFs, but more study is needed. Since radiofrequency EMFs have higher energy than do power line frequencies, one might expect that they would be even more likely to cause disease. The enormous and very recent increase in use of cell phones by children is particularly worrisome. However there is little information at present on the long-term consequences of cell phone use, especially by children.

B. "There is insufficient evidence that adult diseases are secondary to EMF exposure."

It is correct that the level of evidence definitively proving an association between exposure to EMFs and various adult diseases is less strong that the relationship with childhood leukemia. However there are multiple studies which show statistically significant relationships between occupational exposure and leukemia in adults (see Chapter 11), in spite of major limitations in the exposure assessment. A very recent study by Lowenthal et al. (2007) investigated leukemia in adults in relation to residence near to high-voltage power lines. While they found elevated risk in all adults living near to the high voltage power lines, they found an OR of 3.23 (95% CI = 1.26-8.29) for individuals who spent the first 15 years of life within 300 m of the power line. This study provides support for two important conclusions: adult leukemia is also associated with EMF exposure, and exposure during childhood increases risk of adult disease. Thus protecting children from exposure should be a priority.

The evidence for a relationship between exposure and breast cancer is relatively strong in men (Erren, 2001), and some (by no means all) studies show female breast cancer also to be elevated with increased exposure (see Chapter 12). Brain tumors and acoustic neuromas are more common in exposed persons (see Chapter 10). There is less published evidence on other cancers, but Charles et al. (2003) report that workers in the highest 10% category for EMF exposure were twice as likely to die of prostate cancer as those exposed at lower levels (OR 2.02, 95% CI = 1.34-3.04). Villeneuve et al. (2000) report statistically significant elevations of non-Hodgkin's lymphoma in electric utility workers in relation to EMF exposure, while Tynes et al. (2003) report elevated rates of malignant melanoma in persons living near to high voltage power lines. While these observations need replication, they suggest a relationship between exposure and cancer in adults beyond leukemia.

Evidence for a relationship between exposure and the neurodegenerative diseases, Alzheimer's and amyotrophic lateral sclerosis (ALS), is strong and relatively consistent (see Chapter 12). While not every publication shows a statistically significant relationship between exposure and disease, ORs of 2.3 (95% CI = 1.0-5.1 in Qio et al., 2004), of 2.3 (95% CI = 1.6-3.3 in Feychting et al., 2003) and of 4.0 (95% CI = 1.4-11.7 in Hakansson et al., 2003) for Alzheimer's Disease, and of 3.1 (95% CI = 1.0-9.8 in Savitz et al., 1998) and 2.2 (95% CI = 1.0-4.7 in Hakansson et al., 2003) for ALS cannot be simply ignored.

In total the scientific evidence for adult disease associated with EMF exposure, given all of the difficulties in exposure assessment, is sufficiently strong that preventive steps are appropriate, even if not all reports have shown exactly the same positive relationship. While there are many possible sources of false positive results in epidemiological studies, there are even more possible reasons for false negative results, depending on sample size, exposure assessment and a variety of other confounders. It is inappropriate to discount the positive studies just because not every investigation shows a positive result. While further research is needed, with better exposure assessment and control of confounders; the evidence for a relationship between EMF exposure and adult cancers and neurodegenerative diseases is sufficiently strong at present to merit preventive actions to reduce EMF exposure.

C. "The risk is low."

This argument is incorrect because at present it is not possible to determine the magnitude of the risk. Clearly as far as EMFs are concerned there is no unexposed population. Therefore one can only compare groups with different levels of exposure. We can perhaps say with confidence that the elevated risk of leukemia from residential exposure of children to magnetic fields is "low" (meaning ORs in the range of 2-4), but this does not consider the child's exposure to appliances, exposure in automobiles and at daycare or school, exposures in playgrounds and at all of the other places that a child spends time. Even if the risk to one individual is low, the societal impact when everyone is exposed may be very significant.

In addition the exposure assessment is grossly inadequate, even in the best of studies. Most reports deal only with either characterization of the fields within residences or with job titles in occupational settings. Some studies attempt to quantitate other sources of exposure, such as frequency of cell phone usage or use of other appliances, but these studies almost always do not consider residential exposure from power lines. In no investigation has it been possible to follow the exposures of a large number of people over a number of years with accurate monitoring of total exposure to EMFs. This would of course be almost impossible to do for the very good reason that as a person moves through his or her environment the exposures vary from place to place and from moment to moment. However to truly and objectively determine the risk of exposure to EMFs it is essential to consider residential, occupational (or school) and recreational exposures to the full range of the electromagnetic spectrum, including appliances and wireless devices. This has not been accomplished in any study, and without such information it is not possible to determine the overall magnitude of the risk. It is possible, indeed likely, that upon consideration of both childhood and adult diseases that the risk is not low.

D. "There is no animal evidence".

It is correct that there is no adequate animal model system that reproducibly demonstrates the development of cancer in response to exposure to EMFs at the various frequencies of concern. McCann et al. (1997) reviewed the animal studies, and while they found most to be negative there were several that showed suggestive positive results. They also clearly identified issues that need to be improved in further animal carcinogenesis investigations. However Kheifets et al. (2005a) in a policy review noted that "even consistent negative toxicological data cannot completely overcome consistent epidemiological studies. First, a good animal model for childhood leukemia has been lacking. Second, particularly for ELF, the complex exposures that humans encounter on a daily basis and a lack of understanding of the biologically relevant exposure calls into question the relevance of exposures applied in toxicology. Another limitation of toxicologic studies is that animals cannot be exposed to fields that are orders of magnitude more powerful than those encountered by humans, decreasing their power to detect small risks." Further, they conclude that "(A)lthough the body of evidence is always considered as a whole, based on the weight of evidence approach and incorporating different lines of scientific enquiry, epidemiologic evidence, as most relevant, is given the greatest weight."

One positive animal study is that by Rapacholi et al. (1997), who demonstrated that lymphoma-prone transgenic mice developed significantly more lymphoma after exposure to 900 MHz fields (lymphoma being the animal equivalent of human leukemia) than did unexposed animals. More striking is the report from Denver, Colorado using the wire-code characterization originally developed by Wertheimer and Leeper (1979) showing that pet dogs living in homes characterized as having high or very high wire codes, as compared to those with low or very low wire codes or buried power lines, showed a OR of 1.8 (95% CI =

0.9-3.4) for development of lymphoma after adjustment for potential confounders, whereas dogs that lived in homes with very high wire codes had an OR of 6.8 (95% CI = 1.6-28.5) (Reif et al., 1995). This study is impressive because the exposure of the dogs reflects the environment in which exposure has been associated with elevated risk of human cancer in two independent investigations (Wertheimer and Leeper, 1979: Savitz et al., 1988).

It is curious that in many legal situations the courts are reluctant to accept only evidence that substance X causes cancer in animals without corresponding evidence in humans. In the case of EMFs we have strong evidence that EMFs cause cancer in human, but much less evidence from animal models. The US Supreme Court, in the case of Daubert vs. Merrell Dow Pharmaceuticals, effectively ruled that animal studies were not relevant to human health, and that the only admissible evidence must be from human epidemiological studies! While this is certainly not a justifiable conclusion, the situation with regards to EMF health effects is that we have strong evidence for human cancer from epidemiological studies, but do not have good evidence for cancer in experimental animals. But it is humans that we should be concerned about, not the laboratory rats.

E. "We do not know a mechanism."

We do not know the mechanism of cancer in general, although we know a lot about cancer. It came as a major surprise to most scientists when Lichtenstein et al., (2000) reported that genetic factors play a minor role in causing most types of cancer, since it was commonly assumed that genetics was the major cause. However Lichtenstein et al. concluded from their study of identical twins that environmental factors were the initiating event in the great majority of cancers. This does not, of course, mean that genetic susceptibility to environmental contaminants is unimportant, but only that genetic factors alone do not result in cancer. We know mechanisms of action for some carcinogenic substances, but for most cancers we know neither the environmental trigger nor the mechanism of action. So there is no reason to negate the evidence that EMFs cause cancer just because we do not know a single mechanism to explain it's mode of action.

We do not know the mechanism or cause for development of Alzheimer's Disease or ALS. We do know that both are more common in individuals in certain occupations, and that exposure to certain metals appears to be associated with increased risk (Kamel et al., 2002; Shcherbatykh and Carpenter, 2007). In the case of Alzheimer's Disease there are abnormalities of amyloid β and tau protein (Goedert and Spillantini, 2006), but very limited understanding of why or how they form. Neither the association with metals nor the presence of abnormal proteins constitutes a mechanism for cause of disease. So rather than discounting the relationship between EMF exposure and neurodegenerative diseases we should be using this information as a tool to better understand the etiology of these diseases.

There is clear evidence from animal and cell culture studies that ELF and RFR have biological effects. Furthermore, these effects occur at intensities commonly experienced by humans. We know a number of ways in which EMFs alter cell physiology and function, as detailed in various chapters in this report. EMFs affect gene transcription (Chapter 5 and 6), cause the synthesis of stress proteins (Chapter 7) and cause breakage of DNA, probably through generation of reactive oxygen species (Chapter 6 and 9 - Lai and Singh, 2004). Any one of these actions might be responsible for the carcinogenic and neurodegenerative actions of EMFs. However, as with many environmental agents, it would be a mistake to assume that there is only one target or mechanism of action. It is unlikely, for example, that the effects on the nervous system and behavior are secondary to exactly the same cellular targets and actions that lead to cancer. It is likely that there are multiple mechanisms of action leading to disease. But the lack of complete understanding of basic mechanisms does not alter the importance of the relationships.

F. Vested Interests: How They Shape the Public Health Debate

There is no question but that global implementation of the safety standards proposed in this report has the potential to not only be very expensive but also could be disruptive of life and economy as we know it if implemented abruptly and without careful planning. Action must be a balance of risk to cost to benefit. However, "deny and deploy" strategies by industry should not be rewarded in future risk assessment calculations. For example, if significant economic investments in the roll-out of risky technologies persist beyond the time that there is reasonable suspicion of risk available to all who look, then such costs should not be borne by ratepayers (in the case of new powerlines) or by compensating industry for bad corporate choices. Such investments in the deployment of new sources of exposure for ELF and RF should not count toward the balance sheet when regulatory agencies perform risk assessments. Mistakes may be made, but industry should make mid-course corrections to inform and protect the public, rather than deny effects pending "proof". Whether the costs of remedial action are worth the societal benefits is a formula that should reward precautionary behavior. Prudent corporate policies should be expected to address and avoid future risks and liabilities. Otherwise, there is no market incentive to produce safe (and safer) products.

The deployment of new technologies is running ahead of any reasonable estimation of possible health impacts and estimates of probabilities, let alone a solid assessment of risk. However what has been missing with regard to EMF has been an acknowledgement of the risk that is demonstrated by the scientific studies. As discussed in earlier sections, in this case there is clear evidence of risk, although the magnitude of the risk is uncertain, and the magnitude of doing nothing on the health effects cost to society is similarly uncertain. This situation is very similar to our history of dealing with the hazards of smoking decades ago, where the power of the industry to influence governments and even conflicts of interest within the public health community delayed action for more than a generation, with consequent loss of life and enormous extra health care costs to society.

Just because a problem is difficult to solve is not a reason to deny that a problem exists. In fact solutions to difficult issues usually can't be expected until the issues are known and creative thinking is brought to bear to find a solution.

The most contentious issue regarding public and occupational exposures to ELF and RF involves the resolute adherence to existing ICNIRP and IEEE standards by many countries, in the face of growing scientific evidence of health risks at far lower levels. Furthermore there is widespread belief that governments are ignoring this evidence. There are two obvious factors that work against governments taking action to set exposure guidelines based on current scientific evidence of risk. These are: 1) contemporary societies are very dependent upon electricity usage and RF communications, and anything that restricts current and future usage potentially has serious economic consequences and 2) the electric power and communications industries have enormous political clout and even provide support for a significant fraction of what research is done on EMF. This results in legislation that protects the status quo and scientific publications whose conclusions are not always based on only the observations of the research. It hinders wise public health policy actions and implementation of prevention strategies because of the huge financial investments already made in these technologies.

In 1989, in an editorial for Science Magazine, Philip H. Abelson called for more research into low-frequency electromagnetic fields. At that time, he confirmed that a US Office of Technology Assessment (OTA) study had determined that *"(o)verall, the evidence is too weak to allow firm conclusions either way"* but a policy of prudent avoidance strategy was suggested, Abelson defined this as *"to systematically look for strategies which can keep people out of 60 Hz fields"*. Both policy actions were developed in the midst of scientific uncertainty, but rising concern for possible health impacts to the public. At that time, with high level of unknowns, the appropriate level of policy action was prudent avoidance or precautionary action. Nearly two decades later, the level of action warranted is higher – based on many new scientific publications confirming risks may exist – and justifying prevention or preventative action.

III. EMF EXPOSURE AND PRUDENT PUBLIC HEALTH PLANNING

- *The scientific evidence is sufficient to warrant regulatory action for ELF; and it is substantial enough to warrant preventative actions for RF.*

- *The standard of evidence for judging the emerging scientific evidence necessary to take action should be proportionate to the impacts on health and well-being*

- *The exposures are widespread.*

- *Widely accepted standards for judging the science are used in this assessment.*

Public exposure to electromagnetic radiation (power-line frequencies, radiofrequency and microwave) is growing exponentially worldwide. There is a rapid increase in electrification in developing countries, even in rural areas. Most members of society now have and use cordless phones, cellular phones, and pagers. In addition, most populations are also exposed to antennas in communities designed to transmit wireless RF signals. Some developing countries have even given up running land lines because of expense and the easy access to cell phones. Long-term and cumulative exposure to such massively increased RF has no precedent in human history. Furthermore, the most pronounced change is for children, who now routinely spend hours each day on the cell phone. Everyone is exposed to a greater or lesser extent. No one can avoid exposure, since even if they live on a mountain-top without electricity there will likely be exposure to communication-frequency RF exposure. Vulnerable populations (pregnant women, very young children, elderly persons, the poor) are exposed to the same degree as the general population. Therefore it is imperative to consider ways in which to evaluate risk and reduce exposure. Good public health policy requires preventative action proportionate to the potential risk of harm and the public health consequence of taking no action.

IV. RECOMMENDED ACTIONS

A. Defining new exposure standards for ELF

This chapter concludes that new ELF limits are warranted based on a public health analysis of the overall existing scientific evidence. The public health view is that new ELF limits are needed now. They should reflect environmental levels of ELF that have been demonstrated to increase risk for childhood leukemia, and possibly other cancers and neurological diseases. ELF limits should be set below those exposure levels that have been linked in childhood leukemia studies to increased risk of disease, plus an additional safety factor. It is no longer acceptable to build new power lines and electrical facilities that place people in ELF environments that have been determined to be risky. These levels are in the 2 to 4 milligauss* (mG) range (0.2 – 0.4 μT), not in the 10s of mG or 100s of mG. The existing ICNIRP limit is 1000 mG (100 μT) and 904 mG (90.4 μT) in the US for ELF is outdated and based on faulty assumptions. These limits are can no longer be said to be protective of public health and they should be replaced. A safety buffer or safety factor should also be applied to a new, biologically-based ELF limit, and the conventional approach is to add a safety factor lower than the risk level.

While new ELF limits are being developed and implemented, a reasonable approach would be a 1 mG (0.1 μT) planning limit for habitable space adjacent to all new or upgraded power lines and a 2 mG (0.2 μT) limit for all other new construction. It is also recommended for that a 1 mG (0.1 μT) limit be established for existing habitable space for children and/or women who are pregnant (because of the possible link between childhood leukemia and *in utero* exposure to ELF). This recommendation is based on the assumption that a higher burden of protection is required for children who cannot protect themselves, and who are at risk for childhood leukemia at rates that are traditionally high enough to trigger regulatory action. This situation in particular warrants extending the 1 mG (0.1 μT) limit to existing occupied space. "Establish" in this case probably means formal public advisories from relevant health agencies. While it is not realistic to reconstruct all existing electrical distribution systems, in the short term; steps to reduce exposure from these existing systems need to be initiated, especially in places where children spend time, and should be encouraged. These limits should reflect the exposures that are commonly associated with increased risk of child hood leukemia (in the 2 to 5 mG (0.2 to 0.5 μT) range for all children, and over 1.4 mG (0.14 μT) for children age 6 and younger). Nearly all of the occupational studies for adult cancers and neurological diseases report their highest exposure category is 4 mG (0.4 μT) and above, so that new ELF limits should target the exposure ranges of interest, and not necessarily higher ranges.

Avoiding chronic ELF exposure in schools, homes and the workplace above levels associated with increased risk of disease will also avoid most of the possible bioactive parameters of ELF discussed in the relevant literature.

It is not prudent public health policy to wait any longer to adopt new public safety limits for ELF. These limits should reflect the exposures that are commonly associated with increased risk of childhood leukemia (in the 2 to 5 mG (0.2-0.5 μT) range for all children, and over 1.4 mG (0.14 μT) for children age 6 and younger). Avoiding chronic ELF exposure in schools, homes and the workplace above levels associated with increased risk of disease will also avoid most of the possible bioactive parameters of ELF discussed in the relevant literature.

B. Defining preventative actions for reduction in RF exposures

Given the scientific evidence at hand, the rapid deployment of new wireless technologies that chronically expose people to pulsed RF at levels reported to cause bioeffects, whicih in turn, could reasonably be presumed to lead to serious health impacts, is a public health concern. A public health action level that implements preventative action now is warranted, based on the collective evidence. There is suggestive to strongly suggestive evidence that RF exposures may cause changes in cell membrane function, cell communication, metabolism, activation of proto-oncogenes and can trigger the production of stress proteins at exposure levels below current regulatory limits. Resulting effects can include DNA breaks and chromosome aberrations, cell death including death of brain neurons, increased free radical production, activation of the endogenous opioid system, cell stress and premature aging, changes in brain function including memory loss, retarded learning, performance impairment in children, headaches and fatigue, sleep disorders, neurodegenerative conditions, reduction in melatonin secretion and cancers (Chapters 5, 6, 7, 8, 9, 10, and 12).

As early as 2000, some experts in bioelectromagnetics promoted a 0.1 μW/cm2 limit (which is 0.614 Volts per meter) for ambient outdoor exposure to pulsed RF, so generally in cities, the public would have adequate protection against involuntary exposure to pulsed radiofrequency (e.g., from cell towers, and other wireless technologies). The Salzburg Resolution of 2000 set a target of 0.1 μW/cm2 (or 0.614 V/m) for public exposure to pulsed radiofrequency. Since then, there are many credible anecdotal reports of unwellness and illness in the vicinity of wireless transmitters (wireless voice and data communication antennas) at lower levels. Effects include sleep disruption, impairment of memory and concentration, fatigue, headache, skin disorders, visual symptoms (floaters), nausea, loss of appetite, tinnitus, and cardiac problems (racing heartbeat), There are some credible articles from researchers reporting that cell tower -level RF exposures (estimated to be between 0.01 and 0.5 μW/cm2) produce ill-effects in populations living up to several hundred meters from wireless antenna sites,

This information now argues for thresholds or guidelines that are substantially below current FCC and ICNIPR standards for whole body exposure. Uncertainty about how low such standards might have to go to be prudent from a public health standpoint should not prevent reasonable efforts to respond to the information at hand. No lower limit for bioeffects and adverse health effects from RF has been established, so the possible health risks of wireless WLAN and WI-FI systems, for example, will require further research and no assertion of safety at any level of wireless exposure (chronic exposure) can be made at this time. The lower limit for reported human health effects has dropped 100-fold below the safety standard (for mobile phones and PDAs); 1000- to 10,000-fold for other wireless (cell towers at distance; WI-FI and WLAN devices). The entire basis for safety standards is called into question, and it is not unreasonable to question the safety of RF at any level.

A cautionary target level for pulsed RF exposures for ambient wireless that could be applied to RF sources from cell tower antennas, WI-FI, WI-MAX and other similar sources is proposed. The recommended cautionary target level is 0.1 microwatts per centimeter squared (μW/cm2)** (or 0.614 Volts per meter or V/m)** for pulsed RF where these exposures affect the general public; this advisory is proportionate to the evidence and in accord with prudent public health policy. A precautionary limit of 0.1 μW/cm2 should be adopted for outdoor, cumulative RF exposure. This reflects the current RF science and prudent public health response that would reasonably be set for pulsed RF (ambient) exposures where people live, work and go to school. This level of RF is experienced as whole-body exposure, and can be a chronic exposure where there is wireless coverage present for voice and data transmission for cell phones, pagers and PDAs and other sources of radiofrequency radiation. An outdoor precautionary limit of 0.1 μW/cm2 would mean an even lower exposure level inside buildings, perhaps as low as 0.01 μW/cm2. Some studies and many anecdotal reports on ill health have been reported at lower levels than this; however, for the present time, it could prevent some of the most disproportionate burdens placed on the public nearest to such installations. Although this RF target level does not preclude further rollout of WI-FI technologies, we also recommend that wired alternatives to WI-FI be implemented, particularly in schools and libraries so that children are not subjected to elevated RF levels until more is understood about possible health impacts. This recommendation should be seen as an interim precautionary limit that is intended to guide preventative actions; and more conservative limits may be needed in the future.

Broadcast facilities that chronically expose nearby residents to elevated RF levels from AM, FM and television antenna transmission are also of public health concern given the potential for very high RF exposures near these facilities (antenna farms). RF levels can be in the 10s to several 100's of μW/cm2 in residential areas within half a mile of some broadcast sites (for example, Lookout Mountain, Colorado and Awbrey Butte, Bend, Oregon). Like wireless communication facilities, RF emissions from broadcast facilities that are located in, or expose residential populations and schools to elevated levels of RF will very likely need to be re-evaluated for safety.

For emissions from wireless devices (cell phones, personal digital assistant or PDA devices, etc) there is enough evidence for increased risk of brain tumors and acoustic neuromas now to warrant intervention with respect to their use. Redesign of cell phones and PDAs could prevent direct head and eye exposure, for example, by designing new units so that they work only with a wired headset or on speakerphone mode.

These effects can reasonably be presumed to result in adverse health effects and disease with chronic and uncontrolled exposures, and children may be particularly vulnerable. The young are also largely unable to remove themselves from such environments. Second-hand radiation, like second-hand smoke is an issue of public health concern based on the evidence at hand.

V. CONCLUSIONS

- We cannot afford 'business as usual" any longer. It is time that planning for new power lines and for new homes, schools and other habitable spaces around them is done with routine provision for low-ELF environments . The business-as-usual deployment of new wireless technologies is likely to be risky and harder to change if society does not make some educated decisions about limits soon. Research must continue to define what levels of RF related to new wireless technologies are acceptable; but more research should not prevent or delay substantive changes today that might save money, lives and societal disruption tomorrow.

- New regulatory limits for ELF based on biologically relevant levels of ELF are warranted. ELF limits should be set below those exposure levels that have been linked in childhood leukemia studies to increased risk of disease, plus an additional safety factor. It is no longer acceptable to build new power lines and electrical facilities that place people in ELF environments that have been determined to be risky (at levels generally at 2 mG (0.2 μT) and above).

- While new ELF limits are being developed and implemented, a reasonable approach would be a 1 mG (0.1 μT) planning limit for habitable space adjacent to all new or upgraded power lines and a 2 mG (0.2 μT) limit for all other new construction, It is also recommended for that a 1 mG (0.1 μT) limit be established for existing habitable space for children and/or women who are pregnant . This recommendation is based on the assumption that a higher burden of protection is required for children who cannot protect themselves, and who are at risk for childhood leukemia at rates that are traditionally high enough to trigger regulatory action. This situation in particular warrants extending the 1 mG (0.1 μT) limit to existing occupied space. "Establish" in this case probably means formal public advisories from relevant health agencies.

• While it is not realistic to reconstruct all existing electrical distributions systems, in the short term; steps to reduce exposure from these existing systems need to be initiated, especially in places where children spend time, and should be encouraged.

• A precautionary limit of 0.1 (μW/cm2 (which is also 0.614 Volts per meter) should be adopted for outdoor, cumulative RF exposure. This reflects the current RF science and prudent public health response that would reasonably be set for pulsed RF (ambient) exposures where people live, work and go to school. This level of RF is experienced as whole-body exposure, and can be a chronic exposure where there is wireless coverage present for voice and data transmission for cell phones, pagers and PDAs and other sources of radiofrequency radiation. Some studies and many anecdotal reports on ill health have been reported at lower levels than this; however, for the present time, it could prevent some of the most disproportionate burdens placed on the public nearest to such installations. Although this RF target level does not preclude further rollout of WI-FI technologies, we also recommend that wired alternatives to WI-FI be implemented, particularly in schools and libraries so that children are not subjected to elevated RF levels until more is understood about possible health impacts. This recommendation should be seen as an interim precautionary limit that is intended to guide preventative actions; and more conservative limits may be needed in the future.

VI. References

Abelson, PH. 1989. Effects of electric and magnetic fields. Science 245: 241.

Ahlbom A Day N Feychting M Roman E Skinner J Docterty J Linet M McBride M Michaelis J Olsen JH Tynes T and Verkasalo PK 2000. A pooled analysis of magnetic fields and childhood leukaemia. Br J Cancer 83: 692-698.

California Air Resources Board 2005. Appendix III, Part B-Health Effects. Proposed identification of environmental tobacco smoke as a toxic air contaminant.

Carpenter DO and Ahlbom A 1988. Power lines and cancer: Public health and policy implications. Forum Appl Res Pub Policy, Winter, 96-101.

Charles LE Loomis D Shy CM Newman B Millikan R Nylander-French LA Couper D 2003. Electromagnetic fields, polychlorinated biphenyls and prostate cancer mortality in electric utility workers. Am J Epidemiol 157: 683-691.

Erren TC 2001. A meta-analysis of epidemiologic studies of electric and magnetic fields and breast cancer in women and men. Bioelectromagnetics Supplement 5: S105-S119.

Feychting M, Jonsson F, Pedersen NL and Ahlbom A 2003. Occupational magnetic field exposure and neurodegenerative disease. Epidemiology 14: 413-419.

Foliart DE Pollock BH Mezei G Iriye R Silva JM Epi KL Kheifets L Lind MP Kavet R 2006. Magnetic field exposure and long-term survival among children with leukemia. British Journal of Cancer 94 161-164.

Goedert M and Spillantini MG 2006. A century of Alzheimer's Disease. Science 314: 777-784.

Green L 1999. Childhood leukemia and EMF. Cancer Causes Control 10: 233-243.

Greenland S 1987. Quantitative methods in the review of epidemiological literature. Epidemiologic Reviews 9:1-30.

Greenland S Sheppard AR Kaune WT Poole C, Kelsh MA and the Chilhood leukemia-EMF study group 2000. A pooled analysis of magnetic fields, wire codes, and childhood leukemia. Epidemiology 11: 624-634.

Ha M Im H Le M Kim HJ Kim BC Gimm YM and Pack JK 2007. Radio-frequency radiation exposure from AM radio transmitters and childhood leukemia and brain cancer. Am J Epidemiol 166: 270-279.

Hakansson N, Gustavsson P, Johansen C and Floderus B 2003. Neurodegenerative diseases in welders and other workers exposed to high levels of magnetic fields. Epidemiology 14: 420-426.

Hardell L Carlberg M Söderqvist F Hansson Mild K Morgan 2007. Long-term use of cellular phones and brain tumours: increased risk associated with use for ≥ 10 years. *Occup Environ Med*; doi:10.1136/oem.2006.029751.

Hill, AB. 1971. Principles of Medical Statistics Chapter XXIV. Statistical Evidence and Inference, Oxford University Press, Oxford University, Oxford, UK, p. 309-323.

IARC (International Agency for Research on Cancer) 2002. Monographs on the evaluation of carcinogenic risks to humans: Volume 80. Non-ionizing radiation, Part 1: Static and extremely low frequency (ELF) electric and magnetic fields. Lyon, France: IARC Press.

Jarosinska D Gee D. 2007. Children's environmental health and the precautionary principle. Int J Hyg. Environ Health. doi:10.1016/j.ijheh.2007.07.017.

Juutilanen J Kumlin T Naarala J. 2006 Do extremely low frequency magnetic fields enhance the effects of environmental carcinogens? A meta-analysis of experimental studies. Ing J Radiat Biol 82: 1-12.

Kamel F Umbach DM Munsat TL Shefner JM Hu H Sandler DP 2002. Lead exposure and amyotrophic lateral sclerosis. Epidemiology 13: 311-319.

Kan P Simonsen SE Lyon JL Kestle JRW 2007. Cellular phone use and brain tumor: a meta-analysis. J. Neurooncol DOI 10.1007/s11060-007-9432-1.

Kheifets Afifi AA Buffler PA Zhang ZW 1995. Occupational electric and magnetic field exposure and brain cancer: a meta-analysis. JOEM 37:12. 1327-1341.

Kheifets L 2001. Electric and magnetic field exposure and brain cancer: a review. Bioelectromagneetics Supplemnt 5:S120-S131,

Kheifets L Shimkhada R 2005a. Childhood Leukemia and EMF: Review of the Epidemiologic Evidence. Bioelectromagnetics Supplement 7: S51-S59.

Kheifets L Sahl JD Shimkhada R Repacholi MH 2005b. Developing policy in the face of scientific uncertainty: Imterpreting 0.3 or 0.4 μT cutpoints from EMF epidemiology studies. J Risk Anal 25: 927-935.

Kheifets Afifi AA and Shimkhada R 2006. Public health impact of extremely low-frequency electromagnetic fields. Environ Health Perspect 114: 1532-1537.

Lai H and Singh NP 2004. Magnetic-field-induced DNA strand breaks in brain cells of the rat. Environ Health Perspect 112: 687-694.

Lahkola A Tokola K, Auvinen A 2006. Meta-analysis of mobile phone use and intracranial tumors. *Scand J Work Environ Health* 32(3):171-177.

Land Salzburg - Landessanitätsdirektion – Umweltmedizin - Federal State of Salzburg - Public Health Department - Environmental Health Unit, International Conference on Cell Tower Siting, Salzburg Resolution, Salzburg, Austria, June 2000.

Lichtenstein P Holm NV Verkasalo PK Iliadou A Kaprio J Koskenvuo M Pukkala E Skytthe A and Hemminki K 2000. Environmental and heritable factors in the causation of cancer: Analyses of cohorts of twins from Sweden, Denmark and Finland. N Engl J Med 343: 78-85.

Lowenthal RM Tuck DM and Bray IC 2007. Residential exposure to electric power transmission lines and risk of lymphoproliferative and myeloproliferative disorders: a case-control study. Int Med J doi:10.1111/j.1445-5994.2007.01389.x

McCann J Kavet R and Rafferty CN 1999. Testing electromagnetic fields for potential carcinogenic activity: A critical review of animal models. Environ Health Perspect 105 (Suppl 1): 81-103.

Milham S Ossiander EM 2001. Historical evidence that residential electrification caused the emergence of the childhood leukemia peak. Medical Hypoth 56: 290–29

Qio C Fratiglioni , Karp A Winblad B Bellander T 2004. Occupational exposure to electromagnetic fields and risk of Alzheimer's Disease. Epidemiology 15: 687-694.

Reif JS Lower KS Oglivie GK 1995. Residential exposure to magnetic fields and risk of canine lymphona. Am J Epidemiol 141: 352-359.

Repacholi MH, Basten A, Gebski V, Noonan D, Finnie J and Harris AW (1997) Lymphomas in Eμ-*Pim*1 transgenic mice exposed to pulsed 900 MHz electromagnetic fields. Rad Res 147: 631-640.

Rothman KJ Greenland S. 1998. Modern Epidemiology, 2nd ed. Philadelphia: Lippincott-Raven.

Savitz DA Checkoway H Loomis DP 1998. Magnetic field exposure and neurodegenerative disease mortality among electric utility workers. Epidemiology 9: 398-404.

Savitz DA Wachtel H Barnes FA 1988. Case-control study of childhood cancer and exposure to 60-Hz magnetic fields. Am J Epidemiol 128: 21-38.

European Commission, Health and Consumer Protection, 2007. Scientific Committee on SCENIHR Report on Emerging and Newly Identified Health Risks – Possible Effects of Electromagnetic Fields (EMF) on Human Health.

Shcherbatykh I Carpenter DO 2007. The role of metals in the etiology of Alzheimer's Disease. J Alzheimer's Dis 11: 191-205.

Svendsen AL Weihkopf T Kaatsch P Schuz J 2007. Exposure to magnetic fields and survival after diagnosis of childhood leukemia: a German cohort study. Cancer Epidemiol Biomarkers Prev 16(6) 1167-1171.

Tynes T Klaeboe L Haldorsen T 2003. Residential and occupational exposure to 50 Hz magnetic fields and malignant melanoma: a population based study. Occup Enviro Med 60: 343-347.

US Department of Health and Human Services (US DHHS, 2004). The health consequences of smoking: cancer. A report of the Surgeon General. US DHHS Public Health Service, Office on Smoking and Health, U Government Printing Office, Washington DC, 17-24.

US Department of Health and Human Services (US DHHS) 2006. The Health Consequences of Involuntary Exposure to Tobacco Smoke: A Report of the Surgeon General http://www.surgeongeneral.gov/library/secondhandsmoke

Villeneuve PJ Agnew DA Miller AB Corey PN 2000. Non-Hodgkin's lymphoma among electric utility workers in Ontario: the evaluation of alternate indices of exposure to 60 Hz electric and magnetic fields. Occup Environ Med 57: 249-257.

Wartenberg D 1998. Residential magnetic fields and childhood leukemia: A meta-analysis. Am J Public Health 88: 1787-1794.

Wertheimer N Leeper E 1979. Electrical wiring configurations and childhood cancer. Am J. Epidemiol 109: 273-284.

WHO - World Health Organization 2007. Extremely low frequency fields. Environmental Health Criteria, Vol. 238. Geneva, World Health Organization.