Attachment 10

Falcons for Bird Abatement

Environmentally Friendly Bird Abatement - The Natural Solution!

Bird abatement (removal of nuisance birds) using raptors has been proven as the most effective and "green" method available. When coupled with modern technology and cutting edge techniques, the rate of success can be better than 99.99% !

Wild birds in sizable numbers have been known to cause thousands of dollars worth of damage to crops, buildings, airplanes and more. It is not our goal to destroy these invasive animals, but simply to "train" them to move elsewhere.

Current measures typically used include poisoning and/or shooting the birds. This may be an immediate and quick solution, but it creates many other hazards as well. Poisons will affect any animal that consumes the poison such as song birds, and can also affect any animal that may feed on the dead animal such as foxes, vultures, raccoons, or a host of other scavengers. Shooting of the birds not only poses a safety threat from the use of firearms, but the lead left over is toxic to the environment. It too can accumulate in scavengers, but also in the water systems as well. The killing of birds also leads to a large number of dead animals that can spread disease.

Sky Kings has developed several different methods for removing these animals from different scenarios. Common problem birds we handle include, but are not limited to: Pigeons, Starlings, Grackles, Seagulls, Robins, Sparrows, Crows, Ravens, and even Canada Geese!

Refineries - Starlings, Pigeons, and Grackles tend to accumulate on the refining structures for warmth, and shelter. Their feces can destroy expensive equipment, create a hazardous work space, and harbor nasty diseases. We have developed methods using falcons, hawks, and owls to teach the invaders that the refineries are not safe places to roost. Our techniques allow us to reach 99% abatement in just a few weeks!

Warehouses, Feed Lots, Businesses, and other Pigeon Hangouts - Pigeons can be extremely hard to remove, and create incredible amounts of waste, especially when nesting and raising young. We use our falcons to haze birds on the outside of buildings, while using hawks and owls to chase them out of the insides. We also offer humane trapping and removal programs, as well as year long maintenance packages.

Airports-A single bird strike could not only cost millions in damaged aircraft, but cost countless lives. Birds tend to congregate in the open spaces surrounding runways, hangars, and warehouses. Hawks and falcons are employed to chase away feeding or congregating birds to keep the airport free of potential accidents

Landfills-Seagulls are a common problem around landfills. Not only do they leave behind feces, but they spread the trash and debris over miles. Gulls are large and extremely stubborn birds, however they learn quickly to fear falcons and hawks chasing them down. By removing the birds you help prevent pollution from trash being scattered as well as limit the transmission of disease and bacteria.

Orchards/Vineyards-As fruit such as cherries, blueberries, olives, or many other items ripen, birds are naturally attracted to them for food. Robins, starlings and other birds have been known to invade these places on a daily basis to feed. Not only do they cost the growers money in lost fruit, but they must also spend time and money to sort out the damaged product. By flying falcons on a routine basis right before picking begins, and as the fruit ripens, the foraging birds can be kept away by the presence of a predator.

Golf Courses-Recently Canada Geese have begun to invade golf courses and parks. We have developed a method using raptors and dogs to team up and chase geese away. Geese can destroy a newly sodded green, and leave behind a virtual minefield of droppings.

http://skykingsfalconry.com/Bird_Abatement.html

A10-1

Attachment 11

Cumulative Impacts of Towers on Birds …

Briefing Paper on the Need for Research into the Cumulative Impacts of Communication Towers on Migratory Birds and Other Wildlife in the United States
Division of Migratory Bird Management (DMBM), U.S. Fish & Wildlife Service – for Public Release

LAST UPDATED: April 17, 2009 [Comm Tower Research Needs Public Briefing-2-409.doc]

ISSUE: The number of communication towers including radio, television, cellular, microwave, emergency broadcast, national defense, and paging towers has grown exponentially in the U.S. over the past decade. These towers present health and safety challenges for humans, but they are also a growing impact to populations of migratory birds, 4-5 million of which are conservatively estimated to die each year in tower and guy-wire collisions (Manville 2005, 2009). Virtually unknown, however, are the potential effects of non-ionizing, non-thermal tower radiation on avifauna, including at extremely low radiation levels, far below maximum safe[1] exposure levels previously determined for humans.

This briefing paper addresses the need to cumulatively assess the impacts of communication towers on migratory birds both from collisions and radiation, especially neotropical migratory songbirds that are most impacted (Shire *et al.* 2000). The paper discusses some suggested research protocols needed to conduct a nationwide cumulative impacts analysis that would assess effects of tower collisions and radiation on avifauna and on other wildlife pollinators including bats and bees.

BACKGROUND

Light Attraction to Birds in Inclement Weather

Beginning with the earliest reported bird-tower kill in the U.S. (in September 1948 at a 137-m [450-ft] radio tower in Baltimore, MD [Aronoff 1949]), the nighttime attraction of lighting during inclement weather has proved to be a key liability for birds. However, much of the past research focused on carcass collections that were not necessarily correlated to nighttime lighting or to weather events. For example, the first long-term study of the impact of a television tower on birds began in 1955 by the Tall Timbers Research Station in FL. After the first 25 years of the study, 42,384 birds representing 189 species were tallied (Crawford and Engstrom 2001). Kemper (1996) reported collecting more than 12,000 birds killed in inclement weather on one night at a television tower in Eau Clair, WI. Manville (2005, 2007) provided additional details of documented bird-tower collision studies in the U.S., especially in regard to lighting and weather events.

Recently, Gehring *et al.* (2006, 2009) reported where red, steady-burning lights were extinguished allowing only flashing or strobe lights to persist on towers, the lighting change-out resulted in up to a 71% reduction in avian collision mortality at towers in MI. In a short-term

[1] "Safe" levels were based on thermal heating standards, now inapplicable. The standards are nearly 25 years out of date, and the EPA office tasked to direct the human safety issues was eliminated due to budget cuts in the early 1980s. Furthermore, the standards in place do not address the potential effects of radiation on wildlife. No government agency currently monitors the rising background levels of electromagnetic radiation (EMF). Current safety standards assume that non-ionizing radiation is safe if the power is too weak to heat living tissue. However, since the 1980s, growing amounts of published research are showing adverse effects on both humans and wildlife far below a thermal threshold – usually referred to as "non-thermal effects," especially under conditions of long-term, low-level exposure (DiCarlo *et al.* 2002, Levitt and Morrow 2007).

study, Evans *et al.* (2007) looked at lighting attraction at ground level in complete cloud cover, but found that neither red, steady-burning nor red flashing lights induced bird aggregation. They hypothesized that the disorientation to red light only occurs if birds are actively using magnetoreception and the red light creates an imbalance in the magnetoreception mechanism. Additional studies are underway to better understand the mechanisms of lighting attraction.

Published research protocols developed to count and estimate bird-tower kills have been developed (*e.g.,* Avery *et al.* 1978, Manville 2002, Derby *et al.* 2002, and Gehring *et al.* 2009) and will be briefly reviewed below for use in future cumulative effects assessments for both collision and radiation studies.

Potential Radiation Impacts to Birds

In 2002, T. Litovitz (Catholic University, pers. comm.; DiCarlo *et al.* 2002) raised troubling concerns about the impacts of low-level, non-thermal radiation from the standard 915 MHz cell phone frequency on domestic chicken embryos under laboratory conditions. Litovitz noted deformities, including some deaths of the embryos subjected to hypoxic conditions under extremely low radiation doses[2].

Preliminary research on wild birds at cellular phone tower sites in Valladolid, Spain, showed strong negative correlations between levels of tower-emitted microwave radiation and bird breeding, nesting, and roosting in the vicinity of the electromagnetic fields (Balmori 2003). Birds had historically been documented to roost and nest in these areas. House Sparrows, White Storks, Rock Doves, Magpies, Collared Doves, and other species exhibited nest and site abandonment, plumage deterioration, locomotion problems, and even death among some birds found close to cellular phone antennas. Balmori did not observe these symptoms prior to construction of the cell phone towers. Balmori (2004, 2005) noted that the White Stork appeared most heavily impacted by the tower radiation during the 2002-2004 nesting season in Spain. Manville (2005) reported Balmori's (2003) preliminary results, and raised concerns of similar events in the U.S.

Everaert and Bauwens (2007) found strong negative correlations between the amount of radiation presence (both in the 900 and 1800 MHz frequency bands) and the presence of male House Sparrows. In areas with high electric field strength values, fewer House Sparrow males were observed. Everaert and Bauwens' preliminary conclusion, long-term exposure to higher radiation levels was affecting bird abundance or bird behavior in this species. Balmori and Hallberg (2007) reported similar declines in House Sparrows directly correlated with levels of electromagnetic radiation in Valladolid, Spain.

Of concern to DMBM are the potential impacts of radiation on bird populations. Beason and Semm (2002) tested neural responses of Zebra Finches to 900 MHz radiation under laboratory conditions and showed that 76% of the neurons responded by 3.5-times more firings. No studies have yet been conducted in the U.S. on radiation impacts to wild bird populations. Magnetite, a mineral highly sensitive to electromagnetic frequencies (EMFs), has been discovered in human, bird, and fish brains. It has been suggested that radio frequency radiation (RF) may be acting as an attractant to birds since their eye, beak and brain tissues are loaded with magnetite, a mineral highly sensitive to magnetic fields that birds use for navigation (Ritz *et al.* 2004, R. Beason cited in Levitt and Morrow 2007). Communication tower radiation in the U.S. may already be impacting breeding and migrating populations of birds, bees, and other wildlife, based on research conducted in Europe. It is therefore important to gain a far better understanding of the

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[2] *i.e.,* doses as low as 1/10,000 below the allowable "safe" level of radiation (T. Litovitz 2002 pers comm.; DiCarlo *et al.* 2002).

suspected impacts of radiation on birds and other wildlife, particularly if those suspected impacts are having effects on species at the population level.

Potential Radiation Effects on Other Pollinators

Radiation has also been implicated in effects on domestic honeybees, pollinators whose numbers have recently been declining due to "colony collapse disorder" (CCD) by 60% at U.S. West Coast apiaries and 70% along the East Coast (Cane and Tepedino 2001). CCD is being documented in Greece, Italy, Germany, Portugal, Spain, and Switzerland. One theory regarding bee declines proposes that radiation from mobile phone antennas is interfering with bee navigational systems. Studies performed in Europe have documented navigational disorientation, lower honey production, and decreased bee survivorship (Harst *et al.* 2006, Kimmel *et al.* 2006, Bowling 2007). This research needs further replication and scientific review, including in North America. Because pollinators, including birds, bees, and bats, play a fundamental role in food security (33% of our fruits and vegetables would not exist without pollinators visiting flowers [Kevan and Phillips 2001]), as pollinator numbers decline, the price of groceries goes up.

Harst *et al.* (2006) performed a pilot study on honeybees testing the effects of non-thermal, high frequency electromagnetic radiation on beehive weight and flight return behavior. They found that of 28 unexposed bees released 800 m (2,616 ft) from each of 2 hives, 16 and 17 bees returned in 28 and 32 minutes, respectively, to hives. At the 1900 MHz continuously-exposed hives, 6 bees returned to 1 hive in 38 minutes while no bees returned to the other hive. In exposed hives, bees constructed 21% fewer cells in the hive frames after 9 days than those unexposed. Harst *et al.* selected honeybees for study since they are good bio-indicators of environmental health and possibly of "electrosmog." Because of some concerns raised regarding the methods used to conduct the Harst *et al.*(2006) study, specifically the placement of the antenna where bees could contact it (*i.e.,* potentially a bias), the experimental methods need to be redesigned and the studies retested to better elucidate and fine tune the impacts of radiation. The results, while preliminary however, are troubling. Kimmel *et al.* (2006) performed field experiments on honeybees under conditions nearly identical to the Harst *et al.* (2006) protocol except that bees were stunned with CO_2 and released simultaneously 500 m (1,635 ft) from the hives. However, in one of their experimental groups, they shielded the radiation source and antenna in a reed and clay box to address potential biases raised in the Harst *et al.* study. Sixteen total hives were tested, 8 of which were irradiated. After 45 minutes when the observations were terminated, 39.7% of the non-irradiated bees had returned to their hives while only 7.3% of the irradiated bees had.

RESEARCH DISCUSSION

If communication tower collisions are killing 4-5 million or more birds per year in the U.S. due to collisions, what impact – if any – might radiation have on avifauna? Bees? Other wildlife? We simply do not know. In 2000, the Communication Tower Working Group (chaired by DMBM/Manville) developed a nationwide tower research protocol that would assess cumulative impacts from tower collisions nationwide, suggesting the use of some 250 towers of different height, lighting, and support categories. The preliminary cost estimate for a 3-year study was $15 million. No funding was ever acquired and the collision study has not yet been conducted.

The proposed 2000 study was to focus on the collision impacts of communication towers to birds during spring and fall migrations, but the same types of mortality monitoring could be conducted during the late spring/summer breeding seasons, looking particularly for evidence of injury and death to breeding birds in close proximity to communication towers. Radiation levels would need to be measured at the tower sites and nests adjacent to the towers during nesting activity, and bird behavior would also need to be monitored throughout the breeding season. Laboratory necropsies would need to be performed on birds and other wildlife suspected of impacts from radiation to better understand what caused their deaths and to verify that they did not die from blunt force trauma from tower or wire collisions. Pre-construction studies should be performed to assess habitat use by breeding and resident avifauna. Post-construction studies should assess site abandonment, development of deformities, injuries, and deaths. A careful review of the protocols developed by Balmori (2004, 2005), Balmori and Hallberg (2007), Everaert and Bauwens (2007), and others is critical because similar studies should be performed in the U.S.

METHODS FOR ASSESSING AVIAN COLLISION MORTALITY

Methods for Assessing Tall Tower Mortality

Bird strike mortality studies at "tall"[3] communication towers conducted previous to research performed by Avery *et al.* (1978) indicated that most dead birds were found within 60 m (197 ft) of the central communication tower structure. Avery *et al.* assessed songbird mortality at a 369-m (1,210-ft) Omega Loran U.S. Coast Guard tower in ND. Based on daily monitoring during 3 fall and 2 spring migration seasons, 63% of the birds they found dead or injured at this tower were within 92 m (300 ft) of the tower. Avery *et al.* placed tagged bird carcasses (*e.g.*, House Sparrows and European Starlings) in catchment nets and on non-netted habitats (*e.g.*, gravel pads, roads, and marshy plots) to assess persistence and scavenging/predation loss. They completely examined the inner 46-m (150-ft) radius of the tower (concentric circle designated "A") for bird carcasses, including both the areas covered with catchment nets and the non-netted areas. Placing tagged carcasses in random search plots, which are then found or not found and/or removed or not removed, helps determine biases (Erickson *et al.* 1999). However, there are inherent problems associated with using tagged bird carcasses, including the attraction of predators, cost, availability, and adequate sample size (D. Strickland, WEST Inc., pers. comm.).

In addition to the total area assessed during this study (168 ha [415 ac]), for the remainder of the search area, Avery *et al.*(1978) divided the habitat into concentric circles of radii 92 m (designated "B"; 303 ft), 183 m (C; 600 ft), and 731 m (D; 2,398 ft), respectively. Two compass lines (north-south and east-west) divided B, C, and D into 12 substrata beyond the inner core. In each of the substratum, 2 net catchment sampling plots, 12.4 m (41 ft) on a side, were randomly selected. Nylon netting suspended on steel frames 1.5 m (5 ft) high, with the net's center anchored to the ground, was utilized. See Manville (2002) beyond for additional net details.

Sampling nets were demonstrated by Avery *et al.*(1978) to be highly effective in preventing losses to scavengers and predators; none of 33 of the test birds placed in nets during the Avery *et al.* study were taken during the first night, but 12 of 69 test birds placed on non-netted gravel sampling plots were taken during the same period. During the Avery *et al.* study, dead bird searches were made daily at dawn during the peak of songbird migration. In a study at a Tallahassee, FL, television tower – where sampling nets were not used – scavenging was considerably higher; only 10 of 157 birds were left undisturbed after one night (*i.e.*, 93.6% scavenging; Crawford 1971).

Homan *et al.* (2001) placed carcasses of House Sparrows in dense vegetation, comparing searcher efficiencies of humans and canines. The dogs received no special training in carcass searching.

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3 hereafter, towers greater than 61 m (199 ft) above ground level (AGL), generally guyed, and always lit at night.

Thirty-six trials were conducted in 5 x 40-m (16 x 131-ft) study plots. Humans found 45% of the carcasses while dogs found 92%. The ratio of recovered to missed carcasses was approximately 12:1 for dogs and 1:1 for humans, making dogs much more efficient in finding carcasses. Searcher efficiencies were not improved but remained similar when testing residual cover (April searches) versus new growth cover (August searches). Because the protocol in the Homan *et al.* study improved quantitative and qualitative assessments, it provides considerable promise for the research initiatives being proposed in this briefing paper.

Arnett (2006) further tested the dog-search protocols of Homan *et al.* (2001) and others, assessing the abilities of dog-handler teams to recover dead bats at 2 commercial wind turbine facilities. Dogs found 71% of the bats placed during searcher-efficiency trials at Mountaineer, WV, and 81% of those at Meyersdale, PA, while human searchers found only 42% and 14% of the carcasses, respectively. Both dogs and humans found a high proportion of the trial bats within 10 m (33 ft) of the turbine tower, usually in open ground (88% and 75%, respectively). During a 6-day fatality search trial at 5 Mountaineer turbines, dog-handler teams found 45 carcasses while human searchers during the same period found only 19 (42%). As vegetation height and density increased, humans found fewer carcasses while dog-handler team searcher efficiencies remained high. Arnett's (2006) study further reinforces the hypothesis that use of dogs greatly improves efficiencies in finding dead bats very similar to what Homan *et al.* (2001) found for locating passerines. Dog use should be given serious consideration in conducting bird and bat mortality studies at telecommunications towers.

From 2003 through 2005, Gehring *et al.* (2006, 2009) studied 24 tall communication towers in MI. They used flagged, straight-line transects, each technician walking at a rate of 45-60 m (147-196 ft) per minute and searching for carcasses within 5 m (16 ft) on either side of each transect, as suggested by Erickson *et al.* (2003). The transects covered a circular area under each tower with a radius equal to 90% the height of the tower. The straight line transects were much easier to navigate than were circular transects (J. Gehring, Michigan Natural Features Inventory, pers. comm.). Due to dense vegetation, observer fatigue, human error, scavenging by predators, and crippling loss of birds and bats that may have escaped the detection area, Gehring *et al.* tested each technician's observer detection rate and rate of carcass removal. Ten bird carcasses of predominately Brown-headed Cowbirds, with painted plumage to simulate fall song bird migration plumage, were placed once each field season within each study plot to assess observer efficiencies. Likewise, 10-15 predominately Brown-headed Cowbirds were placed by each technician at the edge of designated tower search area to monitor the daily removal of carcasses by scavengers. These carcasses were not painted to avoid placing any foreign scent on them. No catchment nets were used in this study.

Methods for Assessing Short Tower Mortality

Manville (2002) developed a protocol for the U.S. Forest Service (USFS) to study the effects of cellular telecommunications towers on birds and bats, recommending use of elevated catchment nets for a Coconino, Kaibab, and Prescott National Forest study in AZ. Modifying the Avery *et al.* (1978) search protocol, Manville suggested use of 1.9-cm (0.75-in) mesh knitted polyethylene nets, 15 x 15 m (50 x 50 ft) in size, suspended 1.5 m (5 ft) above ground, with 8 gauge monofilament nylon line attached around the periphery of the entire net, supported with 2-m-long (6.5-ft) steel angle posts driven into the ground and spaced every 2-3 m (7-10 ft) apart. He recommended pulling the center of each net close to the ground, securing with monofilament to a cinder block, thus creating a downslope gradient from the edge of the net to its center so a carcass landing in the net would tend not to be blown from the netting edge to the ground by a strong wind. He did not recommend using a wooden lip on the net's edges as Avery *et al.* (1978) had suggested. Materials for each net were estimated to cost $320 (Avery and Beason 2000).

Manville (2002) postulated that use of elevated catchment nets would make finding dead birds killed by tower strikes more reliable, especially under variable habitat conditions (*e.g.*, unsuitable substrate for searching, tall grass, shrubs, roots, boulders, or trees). Manville recommended breaking down the tower's circumference into 3, 120° arcs, then breaking the study plot into 2 concentric circles. The radius of the first circle from the tower's center was 30 m (100 ft) and nets were to be randomly deployed to cover 24% of the total area of that concentric circle, 1 net randomly placed in each 120° arc. For the second concentric circle (30-60 m in radius from the center [100-197 ft]), nets were placed randomly in 8% of the total area, 1 net randomly placed in each of the 3 arcs.

Manville (2002) did not recommend using tagged bird carcasses in the AZ study because he believed that double sampling would address sampling efficiency biases. Double sampling involves (1) net sampling, allowing for an estimate of the number of carcasses that fall beneath each tower and are relatively unbiased for searcher efficiency and carcass removal, and (2) ground sampling where biases are inherent. For short towers, he recommended the entire area the radius of the tower height be completely searched (including under the nets) at dawn each day during the migration season and once weekly during the breeding season. Net sampling allows for adjustment of the ground sampling estimates that would correct for carcass removal and searcher efficiency bias based on the relative difference of the number of carcasses found using the 2 sampling methods at each communication tower studied.

Manville (2002) indicated that the probability of catching a bird in a net would change with increased distance from the tower (*i.e.*, birds my fly or be carried by the wind for a distance before dying). He suggested that if there is a bias because birds tend to die greater than 30 m (100 ft) from a short tower, probabilities can be determined by searching strip transects that radiate from a tower. He recommended using a transect 1.5- 2 times the height of the tower, 15 m (50 ft) wide, placed on a randomly selected compass line. Carcass searches within the transect should help to estimate the area that should be sampled by nets, develop a correction factor outside the radius of the area sampled by the nets, and improve the correction factor for ground surveys conducted exclusive of the net surveys. Manville suggested this transect survey be conducted at least once per week, preferably in the early morning hours, during both migration and breeding seasons. With the recent use of trained dogs to detect and locate dead and injured birds and bats, where dogs have been shown to be at least 50% more effective in finding carcasses, dog use should be considered a viable monitoring alternative (E. Arnett, Bat Conservation International, pers. comm., Homan *et al.* 2001, Arnett 2006).

Derby *et al.* (2002) modified the Manville (2002) protocol to conduct the cellular telecommunications tower study in AZ for the USFS. There, 6 of the 7 cell towers were surrounded by 3-m (10 ft) walls, 29 m (95-ft) long on each side. The walled square was divided into 4 equal blocks, and within 1 of these blocks a 12 x 12-m (40 x 40-ft) nylon mesh net was randomly placed based on net specifications recommended by Manville (2002) but placed > 3 m (10 ft) above the ground to allow company personnel to perform maintenance on the sites. Outside the walled compounds, Derby *et al.* used 4, 6 x 6-m (20 x 20-ft) nets, 3 of the nets randomly set outside the wall to a distance of 30.5 m (100 ft) from the tower, and the 4th net randomly placed in the band from 31 to 61 m (100-200 ft) from the tower. Inside the walled compound the entire area was searched by walking transects 6 m (20 ft) apart (3 m [10 ft] search width). The surveys were performed at dawn 4 times per week during peak songbird migration.

Derby *et al.* (2002) also recommended using straight line transects, 4 oriented perpendicular to the walls, and 4 diagonal from the corners of the wall – representing the "spokes of a wheel."

Each transect was 61 m (200 ft) long, and 6-m (20 ft) wide. Because the Derby *et al.* protocol also used double sampling, no tagged carcasses were used in their study.

Both Manville (2002) and Derby *et al.* (2002) recommended daily searches of all electrical wiring to assess for electrocution and wire collision mortality.

Homan *et al.* (2001) used Labrador retrievers and a Chesapeake Bay retriever to search 6 plots, 5 x 40 m (16 x 131 ft) in size, delineated by flagging, to detect 8 thawed House Sparrow carcasses randomly thrown in each of the plots from 1 m (3 ft) outside the plot, allowing the human or human-dog team to search each plot for 10 minutes. Dogs were kept on 5-m (16-ft) leashes during searches. Humans were active searchers when using the dogs. Searches were not conducted during steady rain or when winds were ≥ 32 km/hr (20 mph). The technique with leashed dogs could easily be used to survey both tall and short tower plots, based on the protocols previously recommended. With the dogs confined to leashes, additional training would be unnecessary.

Arnett (2006) used 2 trained chocolate Labrador retrievers to locate test bat carcasses of different species and in different stages of decomposition at commercial wind turbine facilities on the Appalachian Mountain front in PA and WV. His dogs were trained in basic obedience, "quartering" (*i.e.,* systematically searching back and forth in a 10-m-wide [33 ft] transect), and blind retrieval handling skills. The dogs were trained with dead bats 7 days prior to field trials. When a dog found a test bat, the dog was rewarded with a food treat if it performed the task of finding the bat, sitting or stopping movement when given a whistle command to do so, and leaving the carcass undisturbed. Arnett walked the transect lines at a rate similar to that of humans (*i.e.,* approximately 13-25 m/min [43-82 ft/min]) while the dogs were allowed to quarter the entire width of the transect (5 m [16 ft] on either side of the center line). While this technique was tested on bats, it also shows great promise for use on birds. Dogs would require additional training, but unlike the Homan *et al.* (2001) technique, they would not need to be leashed. The Arnette technique also shows great promise for use at both tall and short communication towers to locate dead birds and bats.

METHODS FOR ASSESSING RADIATION IMPACTS TO BIRDS

Methods for Assessing Radiation Impacts at Tall Towers

At present, radiation studies at tall towers in Europe have not yet been conducted since the impacts to birds and other wildlife have been documented at short, cellular communication towers. The methods suggested below for short tower radiation studies should also be applicable to future tall tower radiation studies.

Methods for Assessing Radiation Impacts at Short Towers

Balmori (2005) selected 60 nests of White Storks in Valladolid, Spain, to monitor breeding success, visiting each nest from May to June 2003, taking care to select nests with similar characteristics located on rooftops. Tree nests were not studied. Nests were selected based on very high (N=30) or very low (N=30) exposure levels of electromagnetic radiation, depending on the distances nests were located from the cell towers. Thirty nests were within 200 m (656 ft) of the towers, while the remaining 30 were located > 300 m (981 ft) beyond any tower. Chick productivity was closely observed. Electric field intensities (radiofrequencies and microwave radiation) were measured using a unidirectional antenna and portable broadband electric field meter set at 10% sensitivity. Between February 2003 and June 2004, 25 visits were made to nests located within 100 m (327 ft) of 1 or several cell phone towers to observe bird behavior. The visits were made during all phases of breeding, from nest construction until Stork fledging. RFs and EMFs were also measured at all nest sites using a unidirectional antenna and field meter.

Balmori and Hallberg (2007) studied the urban decline of House Sparrows in Valladolid, Spain, since this species is in significant decline in the United Kingdom and western Europe, and because it usually lives in urban environments, where electromagnetic contamination is higher. They felt it would be a good biological indicator for detecting the effects of radiation. Forty visits, approximately 1 per month were made between October 2002 and May 2006, and were performed at each of 30 point transect locations (*i.e.*, point counts, the protocol recommended by Bibby *et al.* 2000) between 7 a.m. and 10:00 a.m. by the same ornithologist following the same protocol. At each transect site, all sparrows heard and seen were counted, without differentiating birds by sex and age, and radio frequencies and levels of microwave radiation were recorded using a unidirectional antenna and a portable broadband electric field meter set at 10% sensitivity. Bird densities from each point were calculated based on the number of sparrows per hectare.

Everaert and Bauwens (2007) counted male House Sparrows during the breeding season at 150 point locations (Bibby *et al.* 2000) in 6 residential districts in Belgium, each point location situated at variable distances (mean= 352 m [1,151 ft]; range= 91- 903 m [298- 2,953 ft]) from nearby cell phone antenna towers. Point counts were conducted for 5 minutes, all male House Sparrows heard singing or visible within 30 m (98 ft) were counted, counts occurred between 7 a.m. and 11:00 a.m. when males were most active, and counts were conducted only during favorable weather conditions. Electric field strengths at 900 MHz and 1800 MHz were measured for 2 minutes at each frequency using a portable calibrated high-frequency spectrum analyzer with a calibrated EMC directional antenna. To measure maximum radiation values, the EMC antenna was rotated in all directions.

METHODS FOR ASSESSING RADIATION IMPACTS TO BEES

Methods for Assessing Radiation Impacts to Bees

Harst *et al.* (2006) exposed 4 beehives to 1900 MHz radiation from an antenna placed at the bottom of each hive immediately under the honeycombs, while they left 4 hives unexposed. Each of the 8 colonies contained approximately 8,000 bees. They were set up in a row, with a block of 4 hives equipped with DECT (Digital European Cordless Telecommunications) stations on the bottom of each hive. Metal lattices were installed between the exposed hives to avoid possible effects to the non-exposed control group. The average transmitting power per station was 10 mW, with peak power at 250 mW. The sending signal was frequency modulated and pulsed with a pulsing frequency of 100 Hz. A transparent 10 cm (4 in) plastic tube with a diameter of 4 cm (1.6 in) was mounted at the entrance of each hive to collect single bees and watch them return later to the hives. Twenty-five bees from each hive were randomly selected, stunned in a cooling box, marked with a marker dot on the thorax, and released 800 m (2,616 ft) away from the hives. All marked bees were released simultaneously and were timed from the moment of their release. Return times were noted as the bees each entered the plastic tubes, with the observation lasting 45 minutes. Any bees returning after 45 minutes were disregarded. Bees were able to touch the radiation sending antenna within the hive. Some have asserted that the antenna placement may have resulted in a behavioral bias in regard to bee response, raising a legitimate concern about the methods used to test bee response to radiation in this experiment.

Harst *et al.* (2006) also studied the effects of radiation on bee building behavior using the protocol discussed above. They photographically documented change in honeycomb area, and measured development of honeycomb weight for each hive. Sixteen colonies were selected for this experiment, 8 of which were irradiated, all aligned in a row. At the beginning of the experiment, the empty honeycomb frames were weighed, the hives were filled with bees (400 g [14 ounces]), and provided 250 ml (0.26 quart) food. Bees were fed 2 more times during the 9-day experiment. The honeycombs were photographed each day. The placement of the sending antenna, as previously suggested, may have altered bee behavior and hive productivity.

Kimmel *et al.* (2006) tested 16 bee colonies, 8 of which were irradiated. The experiment was nearly identical to that utilized by Harst *et al.* (2006) except that the sending antenna in 1 experimental group was shielded in a reed and clay box to address concerns about behavioral biases raised in the Harst *et al.* study. Bees were paralyzed using CO_2 instead of cold and were simultaneously released 500 m (1,635 ft) from the hives instead of 800 m (2,616 ft).

RESEARCH RECOMMENDATIONS FOR ASSESSING AVIAN COLLISION IMPACTS

Tall Tower Collision Research Recommendations

We recommend using either the Avery *et al.* (1978) or the Gehring *et al.* (2006, 2009) protocol for tall tower collision studies, depending on the feasibility and availability of catchment nets and dead bird carcasses. Avery *et al.* provided the opportunity to use catchment nets, testing searcher efficiency and carcass removal by placing test carcasses on site (in nets and on the ground). The protocol presumes that the majority of carcasses will be found within a certain distance of the tower's base. The protocol has particular utility for studying very tall towers, especially where terrain around the structures is highly variable and difficult to traverse. It can be used as a standing protocol, or modified as a hybrid based on combining other techniques suggested within this paper such as the use of dogs (Homan *et al.* 2001, Arnett 2006). Dogs have tremendous promise for both tall and short tower studies. If trained hunting dogs are used, then the Arnett (2006) protocol is an excellent tool since the dogs can be used off-leash. However, if untrained hunting dogs are available, then the Homan *et al.* (2001) protocol using leashed dogs is an excellent option.

Gehring *et al.* (2006, 2009) also successfully assessed mortality at tall towers, but catchment nets were not deployed in this study. Due in part to timing, budget constraints, and number of towers studied, this protocol has significant utility where many towers need to be studied. It could also be modified by using trained dogs or incorporating catchment nets.

The statistical designs for both short and tall tower studies – both for assessing collisions and radiation impacts, should be worked out with qualified biometricians. Both the USFWS and the USGS/Biological Resources Discipline (BRD) have well qualified statistical expertise. They should be consulted early in the development of a proposed study.

In both short and tall tower studies, data collection must include all of the following: time of day each tower is examined, time spent searching each site, time since the last search, and weather conditions, particularly inclement weather. Weather data should include the previous night's temperature, wind, cloud cover (clear if < 10% cover, partly cloudy 10-90% cover, or overcast > 90% cover), barometric pressure, rainfall, fog, obscuration, and other relevant weather conditions (Derby *et al.* 2002).

When bird and bat carcasses, and injured vertebrates are found, regardless of the sampling method, data must include tower identification number, name of species (if known), date of collection, closest transect, distance from the tower, azimuth to the tower, exact mapped location (GPS coordinates are very helpful), estimated number of days since death/injury, body condition, probable cause of death, and evidence of scavenging. The carcass is to be collected, numbered, and saved to be used in other investigations (Gehring *et al.* 2009) for which a Federal and possibly state salvage permit will be required (Manville 2002).

Short Tower Collision Research Recommendations

Depending on the availability and utility of catchment nets and the layout of the tower site, we recommend using either the Manville (2002), the Derby *et al.* (2002), Homan *et al.* (2001), or the Arnett (2006) protocols – the latter 2 with greatly improved searcher efficiency, or a hybrid of these methodologies. Manville (2002) suggested using elevated catchment nets, but due to double sampling, he did not recommend using tagged bird carcasses. He also recommended using random transects to adjust for biases.

Derby *et al.* (2002) modified the Manville (2002) protocol, specifically in regard to challenges created by the tower study site in AZ. A randomly-placed catchment net was used within the walled enclosure of each of the sites, and the entire area within the walled compound (ground and net) was searched. Four randomly placed catchment nets were also utilized beyond the walls. Due to double sampling, no tagged bird carcasses were utilized. The protocol could be used as a free-standing technique but should be searched daily during the entire peak of bird migration.

RESEARCH RECOMMENDATIONS FOR ASSESSING RADIATION IMPACTS TO BIRDS

Tall Tower Radiation Research Recommendations

For both short and tall tower studies, any nests close to a tower should be noted, with its GPS coordinates recorded. Breeding, nest success, and survivorship should be monitored, where possible. How birds use their habitats for breeding and residence should be noted, including any issues of site abandonment, egg and clutch failure, development of deformities, injuries, and deaths.

For both short and tall tower studies, where birds appear to be injured or killed by radiation, proximity of the bird/carcass to known nest or roost sites and towers should be noted. Radiation levels at the tower, carcass site, and the nest site should be recorded. Any abnormal behaviors should also be described. Laboratory necropsies should be performed on birds and other wildlife suspected of impacts from radiation to better understand what caused their deaths and to verify that they did not die from blunt force trauma due to collisions. Tower and ambient radiation should be measured using equipment and techniques suggested by Harst *et al.* (2006) and Kimmel *et al.* (2006), or variations of equipment and methods available in the U.S. See the methods section of this paper for specifics.

Where carcass counts need to be assessed at specific tall towers, we suggest using the tall tower collision mortality protocols, discussed above in the methods section of this paper.

Short Tower Radiation Research Recommendations

Depending on the avian species being studied, we recommend using the Balmori (2005) protocol for assessing potential impacts to colonial nesting species such as herons and egrets. Where passerines are to be studied, we suggest the use of the Everaert and Bauwens (2007) and Balmori and Hallberg (2007) protocols for assessing potential impacts. Refer to the methods section above for specific details.

Where carcass counts need to be made at specific short towers, we recommend using the short tower collision mortality protocols, discussed above in the methods section.

RESEARCH RECOMMENDATIONS FOR ASSESSING RADIATION IMPACTS TO BEES

Bees and other pollinators also deserve close scrutiny from the potential impacts of radiation, and their study should be included as part of the overall research effort suggested in this paper. In addition to testing and validating the protocol and results from the Kimmel *et al.* (2006) study (see background and methods sections above), which we recommend be performed at multiple locations in the U.S., bee behavior, hive productivity, and bee survivorship need to be field-tested at both tall and short towers in the U.S. Variations on the protocols used by Harst *et al.* (2006) and Kimmel *et al.* (2006) could easily be developed to field-test potential radiation impacts on bee navigation, flight behaviors, hive productivity, and bee survivorship around both short and tall towers. However, any research protocol developed to assess potential insect impacts – and for that matter, impacts to birds, bats, and other wildlife, must attempt to eliminate extraneous variables that may bias study results. These include everything from antenna placement in the Harst *et al.* (2006) study, to the impacts of diseases, parasites, weather and climatic events, pesticides, contaminants, and other mortality factors on insects and other wildlife. Fine-turning a research protocol must include the combined efforts of trained entomologists, research radiation specialists, ornithologists, wildlife biologists, and biometricians.

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Attachment 12

Property Devaluation

DECREASED REAL ESTATE VALUE
Burbank ACTION (Against Cell Towers In Our Neighborhood)
Source: http://sites.google.com/site/nocelltowerinourneighborhood/home/decreased-real-estate-value

Residents are justifiably concerned about proposed cell towers reducing the value of their homes and properties. Who would want to live right next to one, or under one? And imagine what it's like for people who purchase or build their dream home or neighborhood, only to later have an unwanted cell tower installed just outside their window?

This negative effect can also contribute to urban blight, and a deterioration of neighborhoods and school districts when residents want to move out or pull their children out because they don't want to live or have their children attend schools next to a cell tower.

People don't want to live next to one not just because of health and public safety concerns, but also due to aesthetics, i.e., cell towers become eyesores, obstructing or tarnishing cherished views.

As mentioned on our Home Page, putting cell towers near residential properties is just bad business. For residential owners, it means decreased property values. For local businesses (realtors and brokers) representing and listing these properties, it will create decreased income. And for city governments, it results in decreased revenue (property taxes).
A number of organizations and studies have documented the detrimental effects of cell towers on property values.

1. The Appraisal Institute, the largest global professional membership organization for appraisers with 91 chapters throughout the world, spotlighted the issue of cell towers and the fair market value of a home and educated its members that a cell tower should, in fact, cause a decrease in home value.

The definitive work on this subject was done by Dr. Sandy Bond, who concluded that "media attention to the potential health hazards of [cellular phone towers and antennas] has spread concerns among the public, resulting in increased resistance" to sites near those towers. Percentage decreases mentioned in the study range from 2 to 20% with the percentage moving toward the higher range the closer the property. These are a few of her studies:

a. "The effect of distance to cell phone towers on house prices" by Sandy Bond, Appraisal Journal, Fall 2007, see attached. Source, Appraisal Journal, found on the Entrepreneur website, http://www.entrepreneur.com/tradejournals/article/171851340.html or http://www.prres.net/papers/Bond_Squires_Using_GIS_to_Measure.pdf

b. Sandy Bond, Ph.D., Ko-Kang Wang, "The Impact of Cell Phone Towers on House Prices in Residential Neighborhoods," The Appraisal Journal, Summer 2005; see attached. Source: Goliath business content website, http://goliath.ecnext.com/coms2/gi_0199-5011857/The-impact-of-cell-phone.html

c. Sandy Bond also co-authored, "Cellular Phone Towers: Perceived impact on residents and property values" University of Auckland, paper presented at the Ninth Pacific-Rim Real Estate Society Conference, Brisbane, Australia, January 19-22, 2003; see attached. Source: Pacific Rim Real Estate Society website, http://www.prres.net/Papers/Bond_The_Impact_Of_Cellular_Phone_Base_Station_Towers_On_Property_Values.pdf

2. Industry Canada (Canadian government department promoting Canadian economy), "Report On the National Antenna Tower Policy Review, Section D — The Six Policy Questions, Question 6. What evidence exists that property values are impacted by the placement of antenna towers?"; see attached. Source: Industry Canadahttp://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf08353.html website,

3. New Zealand Ministry for the Environment, "Appendix 5: The Impact of Cellphone Towers on Property Values"; see attached. Source: New Zealand Ministry for the Environment website, http://www.mfe.govt.nz/publications/rma/nes-telecommunications-section32-aug08/html/page12.html

On a local level, residents and real estate professionals have also informed city officials about the detrimental effects of cell towers on home property values.

1. Glendale, CA: During the January 7, 2009 Glendale City Council public hearing about a proposed T-mobile cell tower in a residential neighborhood, local real estate professional Addora Beall described how a Spanish home in the Verdugo Woodlands, listed for 1 million dollars, sold $25,000 less because of a power pole across the street. "Perception is everything," said Ms. Beall stated. "It the public perceives it to be a problem, then it is a problem. It really does affect property values." See Glendale City Council meeting, January 7, 2009, video of Addora Beall comments @ 2:35:24: http://glendale.granicus.com/MediaPlayer.php?view_id=12&clip_id=1227

2. Windsor Hills/View Park, CA: residents who were fighting off a T-Mobile antenna in their neighborhood received letters from real estate companies, homeowner associations and resident organizations in their community confirming that real estate values would decrease with a cell phone antenna in their neighborhood. Attached are copies of their letters to city officials. Source: Report from Los Angeles County Regional Planning Commission regarding CUP Case No. 200700020-(2), from L.A. County Board of Supervisors September 16, 2009, Meeting documents, Los Angeles County website: http://file.lacounty.gov/bos/supdocs/48444.pdf

a. See page 295, August 31, 2008 Letter from Donna Bohanna, President/Realtor of Solstice International Realty and resident of Baldwin Hills to Los Angeles Board of Supervisors explaining negative effect of cell tower on property values of surrounding properties. "As a realtor, I must disclose to potential buyers where there are any cell towers nearby. I have found in my own experience that there is a very real stigma and cellular facilities near homes are perceived as undesirable."

b. See page 296, March 26, 2008 Letter from real estate professional Beverly Clark, "Those who would otherwise purchase a home, now considered desirable, can be deterred by a facility like the one proposed and this significantly reduces sales prices and does so immediately…I believe a facility such as the one proposed will diminish the buyer pool, significantly reduce homes sales prices, alter the character of the surrounding area and impair the use of the residential properties for their primary uses."

c. See Page 298, The Appraiser Squad Comment Addendum, about the reduced value of a home of resident directly behind the proposed installation after the city had approved the CUP for a wireless facility there: "The property owner has listed the property…and has had a potential buyer back out of the deal once this particular information of the satellite communication center was announced….there has been a canceled potential sale therefore it is relevant and determined that this new planning decision can have some negative effect on the subject property."

d. See Page 301, PowerPower presentation by residents about real estate values: "The California Association of Realtors maintains that 'sellers and licensees must disclose material facts that affect the value or desirability of the property,' including 'known conditions outside of and surrounding' it. This includes 'nuisances' and zoning changes that allow for commercial uses."

e. See Pages 302-305 from the Baldwin Hills Estates Homeowners Association, the United Homeowners Association, and the Windsor Hills Block Club, opposing the proposed cell tower and addressing the effects on homes there: "Many residents are prepared to sell in an already depressed market or, in the case of one new resident with little to no equity, simply walk away if these antennas are installed.

f. See Pages 362-363, September 17, 2008, Letter from resident Sally Hampton, of the Windsor Hills Homeowner's Assoc., Item K, addressing effects of the proposed facility on real estate values.

3. Santa Cruz, CA : Also attached is a story about how a preschool closed up because of a cell tower installed on its grounds; "Santa Cruz Preschool Closes Citing Cell Tower Radiation," Santa Cruz Sentinel, May 17, 2006; Source, EMFacts website: http://www.emfacts.com/weblog/?p=466.

4. Merrick, NJ: For a graphic illustration of what we don't want happening here in Burbank, just look at Merrick, NJ, where NextG wireless facilities are being installed, resulting in declining home real estate values. Look at this Best Buyers Brokers Realty website ad from this area, "Residents of Merrick, Seaford and Wantaugh Complain Over Perceived Declining Property Values: http://www.bestbuyerbroker.com/blog/?p=86

5. Burbank, CA: As for Burbank, at a City Council public hearing on December 8, 2009, hillside resident and a California licensed real estate professional Alex Safarian informed city officials that local real estate professionals he spoke with agree about the adverse effects the proposed cell tower would have on property values:

"I've done research on the subject and as well as spoken to many real estate professionals in the area, and they all agree that there's no doubt that cell towers negatively affect real estate values. Steve Hovakimian, a resident near Brace park, and a California real estate broker, and the publisher of "Home by Design" monthly real estate magazine, stated that he has seen properties near cell towers lose up to 10% of their value due to proximity of the cell tower...So even if they try to disguise them as tacky fake metal pine trees, as a real estate professional you're required by the California Association of Realtors: that sellers and licensees must disclose material facts that affect the value or desirability of a property including conditions that are known outside and surrounding areas."

(See City of Burbank Website, Video, Alex Safarian comments @ 6:24:28, http://burbank.granicus.com/MediaPlayer.php?view_id=6&clip_id=848)

Indeed, 27 Burbank real estate professionals in December 2009, signed a petition/statement offering their professional opinion that the proposed T-Mobile cell tower at Brace Canyon Park would negatively impact the surrounding homes, stating:

"It is our professional opinion that cell towers decrease the value of homes in the area tremendously. Peer reviewed research also concurs that cell sites do indeed cause a decrease in home value. We encourage you to respect the wishes of the residents and deny the proposed T-Mobile lease at this location. We also request that you strengthen your zoning ordinance regarding wireless facilities like the neighboring city of Glendale has done, to create preferred and non preferred zones that will protect the welfare of our residents and their properties as well as Burbank's real estate business professionals and the City of Burbank. Higher property values mean more tax revenue for the city, which helps improve our city." (Submitted to City Council, Planning Board, City Manager, City Clerk and other city officials via e-mail on June 18, 2010. To see a copy of this, go here: http://sites.google.com/site/nocelltowerinourneighborhood/home/decreased-real-estate-value/burbank-real-estate-professionals-statement)

Here is also a list of additional articles on how cell towers negatively affect the property values of homes near them:

* The Observer (U.K.), "Phone masts blight house sales: Health fears are alarming buyers as masts spread across Britain to meet rising demand for mobiles," Sunday May 25, 2003 or go here: http://www.guardian.co.uk/money/2003/may/25/houseprices.uknews

* "Cell Towers Are Sprouting in Unlikely Places," The New York Times, January 9, 2000 (fears that property values could drop between 5 and 40 percent because of neighboring cell towers)

* "Quarrel over Phone Tower Now Court's Call," Chicago Tribune, January 18, 2000 (fear of lowered property values due to cell tower)

* "The Future is Here, and It's Ugly: a Spreading of Techno-blight of Wires, Cables and Towers Sparks a Revolt," New York Times, September 7, 2000

* "Tower Opponents Ring Up a Victory," by Phil Brozynski, in the Barrington [Illinois] Courier-Review, February 15, 1999, 5, reporting how the Cuba Township assessor reduced the value of twelve homes following the construction of a cell tower in Lake County, IL. See attached story: http://spot.colorado.edu/~maziara/appeal&attachments/Newton-43-LoweredPropertyValuation/

* In another case, a Houston jury awarded 1.2 million to a couple because a 100-foot-tall cell tower was determined to have lessened the value of their property and caused them mental anguish: Nissimov, R., "GTE Wireless Loses Lawsuit over Cell-Phone Tower," Houston Chronicle, February 23, 1999, Section A, page 11. (Property values depreciate by about 10 percent because of the tower.)

Attachment 13

Mobile Phone-induced Honeybee Worker Piping by Favre

Apidologie
Original article

DOI: 10.1007/s13592-011-0016-x

Mobile phone-induced honeybee worker piping

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Abstract – The worldwide maintenance of the honeybee has major ecological, economic, and political implications. In the present study, electromagnetic waves originating from mobile phones were tested for potential effects on honeybee behavior. Mobile phone handsets were placed in the close vicinity of honeybees. The sound made by the bees was recorded and analyzed. The audiograms and spectrograms revealed that active mobile phone handsets have a dramatic impact on the behavior of the bees, namely by inducing the worker piping signal. In natural conditions, worker piping either announces the swarming process of the bee colony or is a signal of a disturbed bee colony.

worker bee / acoustic communication / mobile phone handset / worker piping / induction

1. INTRODUCTION

Honeybees are essential partners for the success of agriculture. The economical role of honeybees in worldwide pollination has been valued to be around 153 billion euros in the year 2005 (Gallai et al. 2009). Bee losses have been recorded for more than a century (Hart 1893; Aikin 1897; Beuhne 1910; Wilson and Menapace 1979). Scientists suspect many factors to be responsible for the killing of the bees, of which the varroa mite, pesticides, viruses, farming practices, monoculture, hygiene in the hive, and climatic factors are the most widely cited possibilities. Starting in 2003–2004, bee colonies worldwide suddenly began to show symptoms of the so-called colony collapse disorder (CCD). CCD initially affects the worker bees, which desert the hive. The queen bee is usually abandoned in the hive with the young brood and with an abundance of honey, so that the colony can survive for a very short time. However, without the worker bee population, the colony becomes unsustainable and dies out. Never before have honeybees disappeared globally and at such a high rate.

Current theories about the potential cause(s) of CCD essentially include increased losses due to the invasive varroa mite (Donzé et al. 1998). Pesticide poisoning (through exposure to pesticides applied for crop pest control), potential immune-suppressing stress on bees (caused by one or a combination of several factors such as apiary overcrowding, pollination of crops with low nutritional value, pollen or nectar dearth), drought, monocultural practices, migratory stress (brought about by the moving of the bees in long distances), and increased transmission of pathogens have also been usually cited as a cause of CCD (U.S.D.A. 2007). Other causes might include genetically modified crops (Malone and Pham-Delegue 2001) and exceptionally cold winters.

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Recent efforts have been made to study another potential cause responsible for bee losses: man-made electromagnetic fields. The results obtained to date have been highly controversial. In *princeps* studies performed by using digitally enhanced cordless telephones located in the bottom of beehives, it has been shown that exposed honeybees were perturbed in their returning behavior to the hive after foraging (Harst et al. 2006; Diagnose-Funk 2007; Stever et al. 2007).

Honeybees possess magnetite crystals in their fat body cells and they present magnetic remanence (Gould et al. 1978; Keim et al. 2002). These magnetite structures are active parts of the magnetoreception system in honeybees (Hsu and Li 1994; Hsu et al. 2007). Honeybees can be trained to respond to very small changes in the constant local geomagnetic field intensity (Walker and Bitterman 1989a). They can also communicate through chemical and acoustical means (Winston 1991; Tautz 2008). Therefore, the analysis of the sound features of bee colonies was a method of choice in the present study, since it can be correlated with the activity of the bees (Esch 1967; Michelsen et al. 1986; Donahoe et al. 2003; Pierce et al. 2007; Ferrari et al. 2008).

To my knowledge, no systematic studies have been conducted on potential effects of electromagnetic radiation from mobile phones on honeybee behavior. Here, I present results from corresponding original experiments I have carried out with honeybee populations exposed to active mobile phone radiation. The goal of these experiments was to identify potential effects of mobile phone communications on honeybee behavior and to establish simple methodology to enable other beekeepers to reproduce the experiments.

2. MATERIALS AND METHODS

2.1. Sound recording and analysis

An acoustical method based on sound analysis for classification was employed to identify the changes triggered by mobile phone handsets on the behavior of the honeybee *Apis mellifera carnica*. The sounds produced by the bees in their normal activities were recorded as negative control (with or without inactive mobile phones in the hive); activity of the bees was also recorded with active mobile phones in the hive (see below). Five healthy hives (either Dadant-Blatt or Swiss Bürki types) were monitored for sound during several recordings performed between February and June 2009. During the previous autumns and winters, the bees had been treated against the varroa mite *Varroa destructor* with formic acid and oxalic acid, as recommended elsewhere (Charrière et al. 2004). Beehives were located either in the beekeeping and apiary school of the city of Lausanne (altitude, 749 m) or in a second site used by beekeepers north of the city of Morges (altitude, 510 m; both locations in Switzerland). The recording device consisted of a bidirectional compact microphone (Olympus ME-31) with frequency response from 70 to 14,000 Hz connected to a vocal recorder (Olympus LS-10). The use of omnidirectional microphones such as the ECM 3005 (Monacor) or the electret condenser 33-3013 (Radio Shack) is also possible, as described elsewhere (Ferrari et al. 2008; Rangel and Seeley 2008). The recorded signal was digitized as a Waveform audio file format sound file with 160 kbps. The computer program Adobe Audition 1.5 was employed for the manual analysis of the sound files and for the generation of the audiograms (also called sonograms) and spectrograms (oscillograms), as described elsewhere (Ferrari et al. 2008).

In this pilot study, more than 80 different sound recordings were performed in five different hives throughout the assay period starting early February and ending June 2009. In the geographic area where the experiments took place, the bees usually begin to forage to collect nectar and pollen in early March, depending on the weather conditions.

Sounds made by honeybees were recorded in the two conventional models of hives (Swiss Bürki and Dadant-Blatt) that are found in Switzerland.

2.2. Mobile phone experimental arrangement

Two mobile phone handsets were randomly chosen from a selection of four different apparatus having specific energy adsorption rate (SAR) values of either 0.271, 0.62, 0.81, or 0.98 W/kg (tissue) and

900 MHz GSM roaming (Global System for Mobile communications, originally from *Groupe Spécial Mobile*). The sum of the two random SAR values was always below the 2-W/kg maximum upper limits recommended in the guidelines of the International Commission on Non-Ionizing Radiation Protection (I.C.N.I.R.P 1998). Four different subscriber identity module cards unrelated to the experimenter were randomly used.

For negative controls, the two apparatus were not present in the hive during the recording of the natural background sounds made by the bees. For undisturbed control experiments ("sham" experiments), the two mobile phone handsets were either shut down or kept in the standby mode. The basic setup of the experiments is schematically shown in Figure 1.

In order to establish whether inactive mobile phone handsets perturbed the behavior of the bees, two mobile phone handsets were placed in the hive in close vicinity of the honeybees. In a first series of experiments (negative control; n=8), two inactive ("off" mode) mobile phone handsets were placed in the hive for up to 24 h. In a second series of experiments (sham experiments, "standby" mode; n=10), the two mobile phone handsets were kept in the hive in the standby mode, for prolonged periods of time (4 to 24 h). As positive control experiments, the two mobile phone handsets were employed in an active communication mode. The first mobile phone was placed in the hive and was supplemented with a hands-free kit, the mini microphone of which was held in front of a radio apparatus maintained outside the hive (≈60 cm away, so that it does not interfere with the recording performed by the microphone near the bees) and constantly playing the France info program (output of the small radio loudspeaker, −18±2 dB at 1 cm). This enables a permanent signal to be sent from this first to a second telephone, otherwise without this signal the communication is automatically interrupted after a period of time. To generate a mobile phone communication near the bees, the first mobile phone was

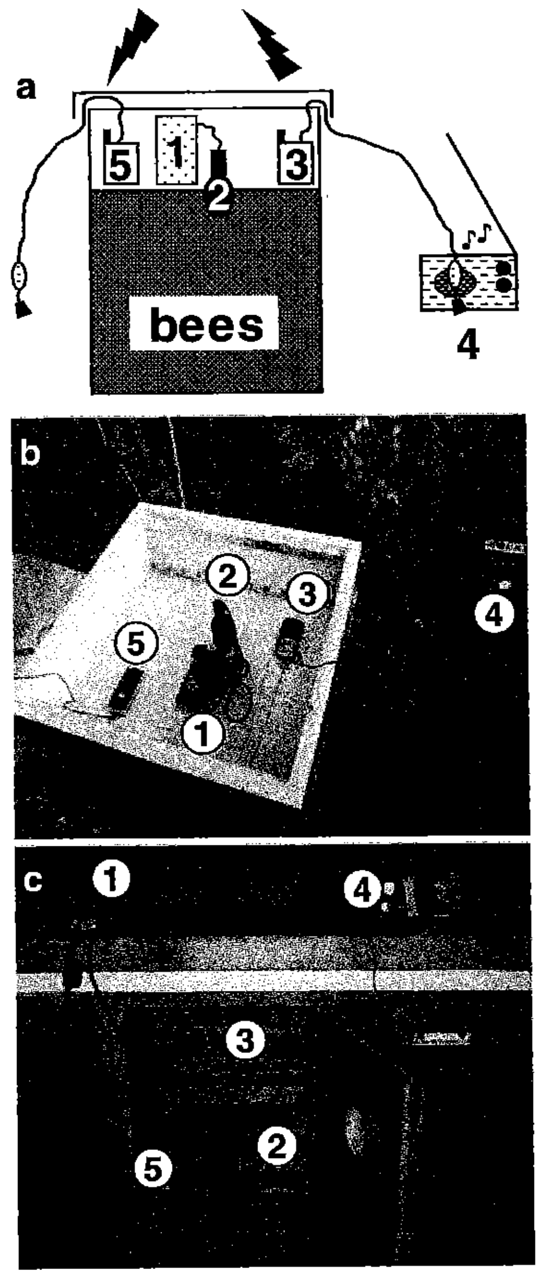

Figure 1. Apparatus positioning in the different hives. ▶ **a** Schematic drawing. Sound recorder *1* was connected to a microphone *2*, the latter was placed in the close vicinity of the bees in the hive. The first (emitting) mobile phone *3* was connected with hands-free kit, the latter having its small microphone maintained on the loudspeaker of a radio apparatus *4*. A second (receiving) mobile phone *5*, also having a hands-free kit, was also kept inside the hive. The use of the radio apparatus is intended to allow a permanent communication between the two mobile phone handsets, in order to avoid unwanted disconnection after a while. **b** Image of a Dadant-Blatt model of beehive. The microphone is placed through the upper nourishing hole. **c** Image of a Swiss Bürki model of beehive. The microphone was placed behind a board having a grid instead of a glass plate. During the experiments, the door of the Bürki hive was closed and the Dadant-Blatt hive was covered with the roof. A similar positioning can be easily performed with other types of beehives.

triggered to call a second mobile phone that was also placed in the hive. The communication was established after a ringing signal lasting from 5 to 10 s. This second apparatus was also supplemented with a hands-free kit. The sum of the SAR values of the two mobile phones was always below the recommended limit of 2 W/kg, as mentioned above. Several independent experiments (n=12) with the presence of actively communicating mobile phone handsets in the hive were performed. The established active mobile phone communication could be controlled at any time in two different ways: by direct hearing of the communication using the hands-free kit from the second mobile phone, or by controlling the functional state of the communication by calling—from a third independent telephone—one of the two active mobile phone handsets involved in the experiment.

For each experiment, local weather parameters (temperature, wind, precipitation, atmospheric pressure, and duration of sunshine) were obtained from the Office Fédéral de Météorologie et de Climatologie (MétéoSuisse).

3. RESULTS

3.1. Background control experiments

The analysis of the sound files revealed similar characteristics and events that were not dependent on the model of the beehive (Figure 2). Beehives undisturbed by a mobile phone apparatus revealed the same sound characteristics as previously reported for other honeybee colonies (see "Discussion"). The fundamental frequency of *A. mellifera carnica* was in the range of 450 to 500 Hz. Slightly less activity of the bees was recorded during the night than during the day. More sound intensities were recorded during spring and early summer than during winter, thus probably reflecting the number of the active bees present in the hives.

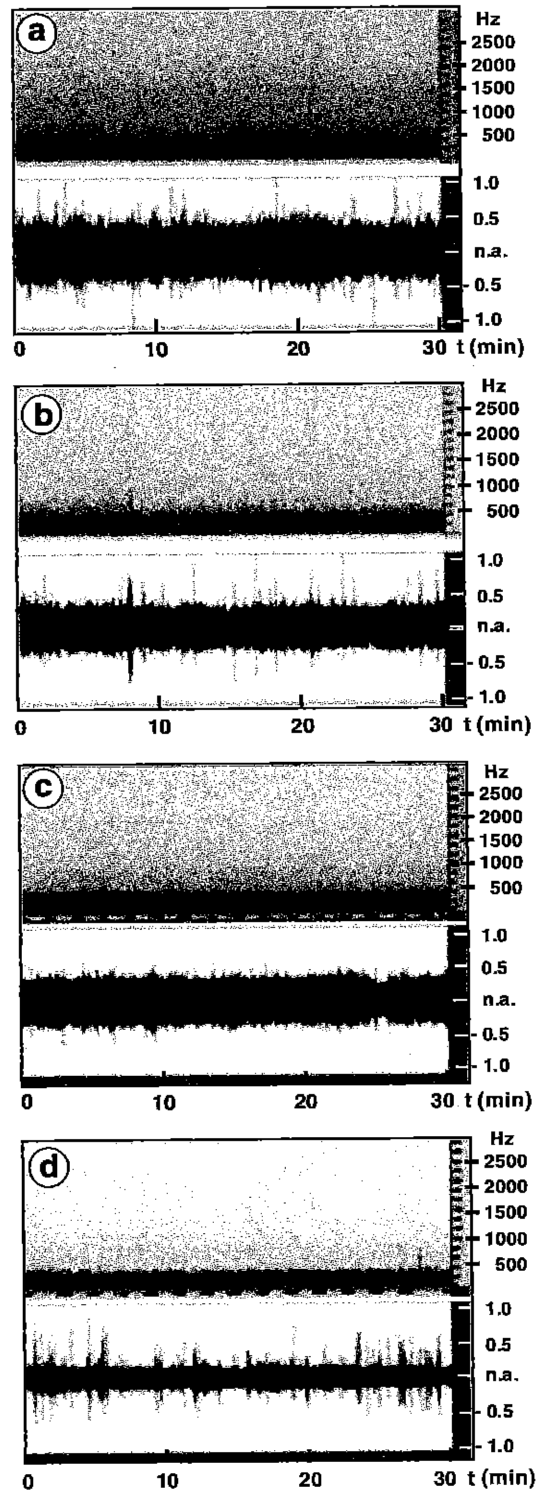

Figure 2. Spectrograms and audiograms of hive ▶ sounds. **a, c** Swiss Bürki model. **b, d** Dadant-Blatt model. **a, b** without any mobile phones in the hive. **c, d** with two mobile phones kept in standby mode in the hives. Intensity values of audiograms might vary between beehives, depending on the microphone positioning and the number of bees in the undisturbed hive. Spectrograms are reported in hertz (*Hz*); audiograms are normalized (*n.a.* −1 to +1). Time (*t*) is indicated in minutes.

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3.2. Mobile phone handsets in standby mode in the hive

The analysis of the various sound files revealed that the bees were not disturbed by these inactive or standby mobile phone handsets, since no dramatic changes in the fundamental intensity and frequency patterns of the sounds produced in the hive were recorded (Figure 2c, d), as compared to the background experiments performed without any mobile phone handsets (Figure 2a, b).

3.3. Mobile phone handsets activated in the hive

A result from a typical sound recording experiment is shown in Figure 3a. Mobile phone handsets in the hive were initially kept for a while (around 25 min) in standby mode and then put in an active communication mode. Sound analysis in the beehive revealed that the bees initially remained calm after the onset of the communication mode, but started to produce sounds that were higher in both frequency and amplitude after about 30 min of communication of the mobile phone handsets. After about 15 additional minutes, the mobile phone handset communication was interrupted. The bees returned to a quiet state after 2 to 3 min, since the frequency and intensity in the hive had returned to the basal values recorded in the beginning of the experiment. Negative control runs showed that the radio itself did not induce any changes in bee behavior with mobile handsets deactivated.

In order to assess how much time the bees would need to return to a basal sound status after mobile phone communication, experiments were performed by placing in the hive actively communicating mobile phone handsets for prolonged periods of time ranging up to 20 h. Sound analysis revealed that the bees' sound values increased in both the intensity and amplitude ranges throughout the experimental period, as compared to background values prior to onset of the mobile phone communication. In each of the independent experiments, both the sound intensity and the frequency increased about 25 to 40 min after the onset of the mobile phone communication. Twelve hours after the cessation of the mobile phone communication in the hive, the bees were still producing more sound in both intensity and frequency as compared to the initial background mode, suggesting that the behavior of the bees remained perturbed for up to 12 h after the end of a prolonged mobile phone communication. Analysis of a shorter period of time lasting 3 min is presented (Figure 3b).

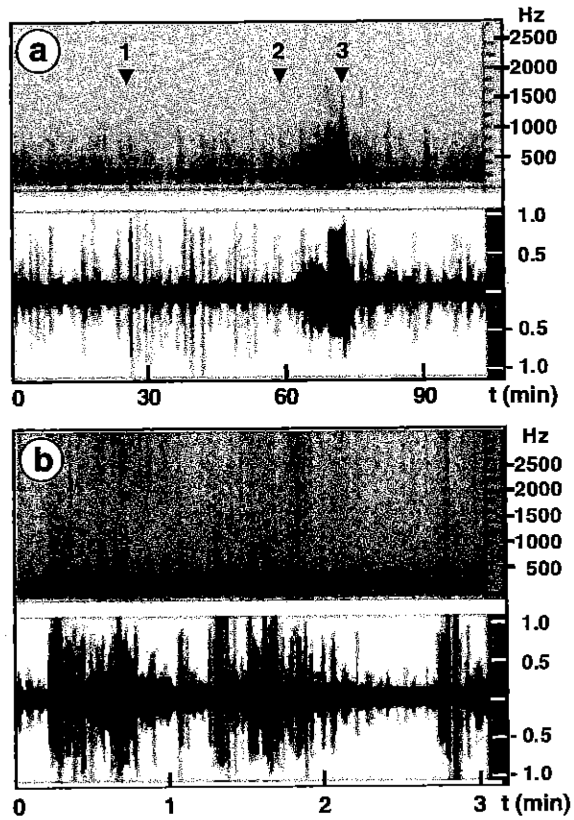

Figure 3. Induction of honeybee worker piping by mobile phone handsets. **a** standby mobile phone handsets in the hive were activated 25 min. after the onset of the experiment (*1*). The beginning of increased noise and frequency in the hive was observed ca. 35 min later (*2*) and is indicated by a *longer arrow*. The cessation of the mobile phone communication is indicated (*3*). **b** Recording of bee noise in a hive submitted to prolonged (20 h) active mobile phone handsets. Spectrograms are reported in hertz (*Hz*); audiograms are normalized (*n.a.* −1 to +1). Time (*t*) is indicated in minutes.

When the sound produced by honeybees in hives containing active mobile phone handsets was analyzed in more detail, it was determined that the bees were producing the so-called "worker piping" (Figure 4a). Spectrograms obtained in the present study revealed various modes of worker piping. First, bimodal pipes having a fundamental frequency of around 150–250 Hz and a duration of about 200±51 ms (n=60 pipes) and 430±103 ms (n=30 pipes) were recorded throughout the experiment involving mobile phone handsets communication in the hive. The harmonic nature of each pipe, as compared to results presented elsewhere (Seeley and Tautz 2001), was also evident. Another shorter type of worker piping, having a fundamental frequency of around 400–500 Hz and a duration of about 9±2 ms (n=50 pipes), was also recorded as a prolonged succession of pulses lasting together up to 2 s (Figure 4b). This short piping signal was also presenting harmonic features ranging up to several thousand hertz. Two other types of signals were also recorded; however, less often than the two signals described above, a strong harmonic piping signal with a basal frequency of 500±50 Hz and lasting 75±15 ms (Figure 4c; n=10) and a signal with a basal frequency of around 2,250±250 Hz and lasting 225±50 ms (n=10; Figure 4d). Analysis of some recordings presented a mixture of the signals mentioned above (Figure 4e). All these different signals were recorded solely in beehives that were subjected to the influence of actively communicating mobile phone handsets, irrespective of both the location and the season when the experiments were performed. Moreover, the observations of worker piping were also independent of the weather conditions prevailing during the experiments.

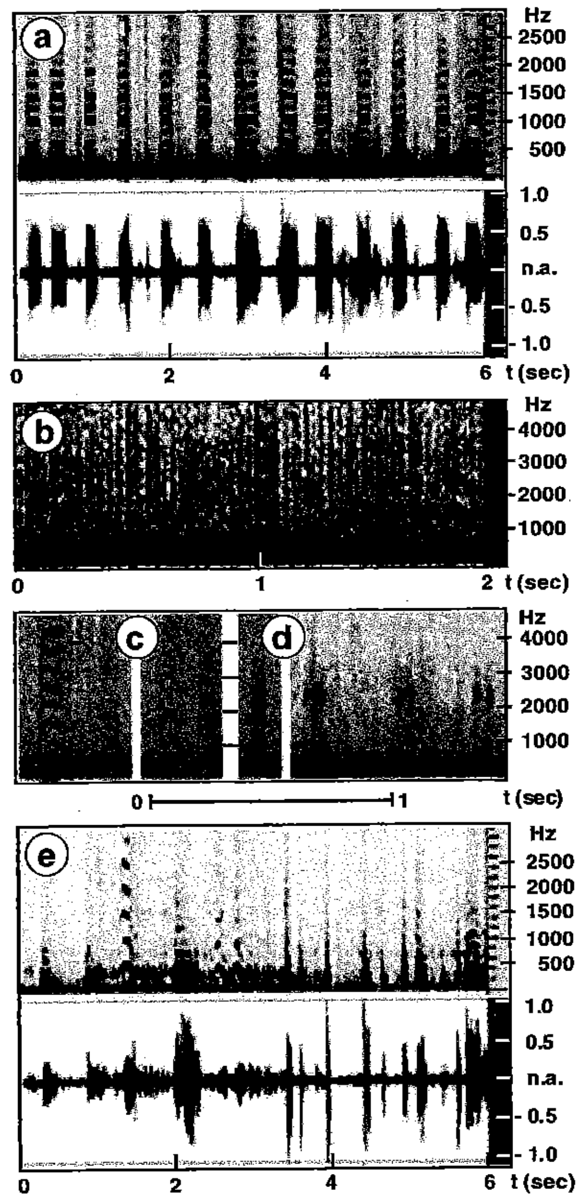

Figure 4. Mobile phone-induced honeybee worker piping. Various modes of worker piping (**a–e**) were recorded in the presence of actively communicating mobile phone handsets in the hive. Spectrograms are reported in hertz (*Hz*); audiograms are normalized (*n.a.* −1 to +1). Time (*t*) is indicated in seconds.

4. DISCUSSION

The results of the present pilot study clearly show that the presence of actively communicating mobile phone handsets in the close vicinity of honeybees had a dramatic effect, namely the induction of worker piping which was regularly observed about 25 to 40 min after the onset of the mobile phone communication. This observation means that: (1) honeybees are sensitive to pulsed electromagnetic fields generated by the mobile telephones and (2) under these circumstances, observable changes in the behavior of the bees are not artificial, but can be proven to occur reproducibly. Although mobile phones are not present in the close vicinity of honeybees in real life, this study provides elements for the establishment of further experiments involving such apparatus placed at increasing distances from the bees. Potential consequences of these observations are discussed below in more detail.

4.1. Rationale of the experimental design

The experimental design employed was set up in order to enable beekeepers and researchers in the field to easily reproduce the experiments with the use of conventional materials and user-friendly computer programs. Honeybees are usually not living in the close vicinity of electromagnetic fields induced by mobile phone handsets in the hive. However, the conditions employed in the present experiments have biological significance, since the sum of the SAR values from the two mobile phone handsets were always below the 2-W/kg maximal value recommended for this frequency (I.C.N.I.R.P 1998). It seems likely that a similar effect on bees can occur with relatively low-dose exposure over a prolonged period of time. In this context, it should be emphasized that radio frequency electromagnetic fields (RF-EMF) have increased by an order of magnitude over the last 20 years in Switzerland; a mean weekly exposure of 0.13 mW/m^2 (83.8% of all emitting RF-EMF) has been reported (Frei et al. 2009). Since both randomly visited outdoor locations and the proximity to mobile phone base stations showed a mean RF-EMF exposure of 0.21 mW/m^2, experiments employing two mobile phone handsets in the hive were finally chosen for practical reasons. The experiments described in this article might therefore be applicable everywhere, since nearly all countries in the world today are readily covered with GSM networks (GSM roaming, coverage maps).

4.2. Mobile phone handsets and induced honeybee worker piping

It is known that honeybees possess magnetite crystals in their fat body cells and that they present magnetic remanence (Gould et al. 1978; Keim et al. 2002). These magnetite structures are active parts of the magnetoreception system in honeybees (Hsu and Li 1994; Hsu et al. 2007). Importantly, it has been shown that honeybees can be trained to respond to very small changes in the constant local geomagnetic field intensity (Walker and Bitterman 1989a). In that study, magnetic anomalies as low as 26 nT (nanoTesla) were responsible for changes in the foraging behavior. Moreover, attached magnets impair magnetic field discrimination by honeybees (Walker and Bitterman 1989b). Therefore, it remains to be established which minimal level in variations of the local pulsed electromagnetic fields induced by mobile phone handsets and base stations might trigger changes in the bees' behavior, such as the induction of honeybee worker piping shown here. It is known for several decades that worker piping is associated with disturbance of the hive by, for example, intruders or jarring (Wenner 1964). The latter author recorded sounds that were called "croaking" and "bipping." This may present one explanation for the present observations assuming that mobile phone handsets triggered disturbances in the hive in a similar way (see Figure 4).

The experiments presented in this pilot study should be reproduced in hives totally protected or not with additional copper or aluminum Faraday cages. Additional clues for the ferromagnetic transduction hypothesis (Kirschvink and Gould 1981) and a plausible mechanism for the sensitivity of honeybees to localized electromagnetic anomalies might therefore be obtained. Such behavioral changes cannot only be analyzed at the behavioral level with sound analysis, but also at the molecular level by studying the gene expression profiles using microarrays, as it was done for the infestation of honeybees with the varroa mite (Navajas et al. 2008).

Although worker piping can be associated with foraging in undisturbed queenright colonies of honeybees (Pratt et al. 1996), it is usually a signal that is produced shortly before takeoff of a swarm (Seeley and Tautz 2001; Rangel and Seeley 2008). Worker piping in a bee colony is not frequent, and when it occurs in a colony, that is not in a swarming process, no more than two bees are simultaneously active (Pratt et al. 1996). The induction of honeybee worker piping by the electromagnetic fields of mobile phones might have dramatic consequences in terms of colony losses due to unexpected swarming. The present study suggests that active mobile phone handsets in beehives noticeably induce the rate of worker piping. However, no evidence for piping of the laying queen (see Schneider and Lewis 2004) was observed.

In the present study, no swarming process was initiated after 20 h of exposure to mobile phone handsets, even though the piping signal was observed. It should therefore be hypothesized that although the piping signal is serving as a primer for swarm exodus other modalities and/or signals (e.g., the shaking and buzz-run signals or chemical components) may be required in the complex swarming process (Rangel and Seeley 2008). The "buzz-run" or "*Schwirrlauf*" rate is perhaps the required crucial signal that appears 15 min before the massive exodus of honeybees during the swarm departure process (Seeley and Tautz 2001; Rangel and Seeley 2008). Moreover, it might be possible that a more prolonged exposure (>20 h) of the honeybees to the actively communicating mobile phone handsets is required for the complete induction of the swarming process. Recently, a study suggested that cell phones and cellphone towers near beehives interfere with honeybee navigation: in one experiment, it was found that when a mobile phone was kept near a beehive it resulted in collapse of the colony in 5 to 10 days, with the worker bees failing to return home, leaving the hives with just queens, eggs and hive-bound immature bees (Sahib Pattazhy 2009). To minimize harm to the bees, it was decided to limit their continuous exposure to mobile phone communications to a maximum of 20 h in the present study.

Further confirmation of the current results and their implications regarding a direct correlation between erratic honeybee behavior and mobile phone-generated electromagnetic fields would substantiate one more explanation for the "disappearance" of bee colonies around the world. This phenomenon accounts for 43% of all bee losses, apart from overwintering (39%), mite disease, (15%) and pesticides (3%) as recently described in a national survey performed in the United States (Bee Alert Technology 2007). Experiments should be undertaken to establish the correlation between the time necessary for the onset of worker piping and the intensity of the electromagnetic fields present in the vicinity of the beehive. For future experiments, in complement to the present original study and in order to reach more "natural" conditions, mobile phone apparatuses should be placed at various increasing distances away from the hives. Video recordings showing the modifications in the bees' behavior in the hive should also be performed.

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Son émis par les ouvrières en réaction à la proximité d'un téléphone portable

Ouvrière / communication accoustique / téléphone portable / stimulus

Mobiltelefon induzierte Piepstöne von Arbeiterinnen der Honigbiene. In den letzten Jahren häufen sich Berichte über einen weltweiten Schwund an Honigbienen in Folge einer Völkerverlustkrankheit (colony loss disease, CCD), bei der Völker massiv und plötzlich eingehen, ohne dass es vorhergehende Anzeichen einer Krankheit oder Parasitenbefall gibt. CCD hat schwerwiegende Auswirkungen für den Anbau vieler Früchte und Gemüse, die auf Bestäubung durch Insekten angewiesen sind Milbenbefall, Pestizide, eine reduzierte Immunität, bakterielle und virale Infektionen, genetisch modifizierte Feldfrüchte und Anbaupraktiken stehen im Verdacht, eine Rolle

beim Schwund der Bienenvölker zu spielen. Berichten in wissenschaftlichen und allgemeinen Medien zufolge besteht auch die Möglichkeit, dass Mobiltelefone hierzu beitragen können, da Bienen Schwierigkeiten bei der Heimfindung hatten, wenn Basisstanionen für schnurlose Telefone unter den Völkern installiert waren. Mikrowellen könnten demzufolge einen Teil der Verantwortung für das CCD-Syndrom tragen. In dieser Arbeit untersuchte ich die potentiellen Effekte von konventionellen Mobiltelefonen produzierten elektromagnetischen Feldern auf Honigbienen. Hierzu wurden zwei Geräte im aktiven Modus und mit einer Summe an spezifischen Energieabsorptionsraten unterhalb der offiziellen internationalen Maximalwerte (2 Watt pro Kilo Gewebe) in der Nähe von Bienen aufgestellt und die von Bienen produzierten Piepstöne aufgezeichnet und analysiert. Dies zeigte, dass sich Bienen durch die aktiv kommunizierenden Mobiltelefone im Volk gestört fühlten und zum Senden von Piepstönen angeregt wurden. Unter natürlichen Bedingungen sind solche Piepstöne ein Signal für die Schwarmvorbereitung oder eine Reaktion auf Störungen im Volk. Das Senden von Piepstönen setzte nicht sofort nach Einschalten der Mobiltelefone ein, sondern erst nach 25 bis 40 Minuten. Diese Beobachtungen weisen darauf hin, dass die Bienen für pulsierende elektromagnetische Felder empfänglich sind und sensibel auf Verhaltensänderungen reagieren. Ein Schwund an Bienenvölkern wird v.a. in Erdteilen beobachtet (Nordamerika, Europa, Australien, Südbrasilien, Taiwan und Japan), in denen Mobiltelefone weit verbreitet sind. Es stellt sich daher die Frage, ob der Zusammenhang von CCD und einer intensiven Nutzung von Mobiltelefonen noch als reine Spekulation angesehen werden kann.

Arbeiterinnen / akustische Kommunikation / Mobiltelefon / Arbeiterinnenpiepstöne

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