Attachment 14

EM Exposure Impact on Bee Behavior by Harst, Kuhn, Stever

Can Electromagnetic Exposure Cause a Change in Behaviour?
Studying Possible Non-Thermal Influences on Honey Bees – An Approach within the Framework of Educational Informatics

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Abstract
In recent years the public discussion has been focused increasingly on possible unhealthy effects of high-frequency electromagnetic fields (particularly of mobile-phones) on human beings. Whereas thermal effects of this radiation could be explained very well, non-thermal effects could hardly be clarified. In our last works, we pointed out that – from view of Educational Informatics – honey bees are suitable bioindicators to serve as a model of a living being to study learning processes especially in this aspect.
In this paper, we describe a first pilot study, which explores the non-thermal influence of high-frequency electromagnetic fields. Therefore we observe the behaviour of honey bees (*apis mellifera carnica*) by exposing them to the radiation of DECT-phones. In this study four respectively eight bee-colonies were used as experimental group and were irradiated, whereas the same numbers of comparable bee-colonies was field-free. The observed parameters were the building behaviour of the bees within the beehive, its weight and especially the bees' returning behaviour.

Key words
Electromagnetic exposure, non-thermal, bioindicator, honey bees, learning process, changing behaviour

Introduction
The modern media together with the increasing use of mobile computing in education produce, among other things, an increasing public debate about possible side effects of electromagnetic exposition on human beings. In recent years further studies were initiated to examine the effect of high-frequency electromagnetic radiation on living organisms and cells. But up to now there exists no adequate model of effect with specific relation to learning processes to explain the different, especially non-thermal effects. In this context we only want to mention the resonant stimulus of living organisms, especially of their brain, by high-frequency electromagnetic fields of mobile phones. This could be observed as alterations in the learning behaviour of the organism.
Because studies using human beings are banned in this field, adequate bioindicators should be used to evaluate a possible model. Therefore it is necessary that the brainstructure of the bioindicator is similar in important aspects to that of human beings and that it could be resonantly stimulated by the frequency of mobile phones because of its size. Consequently it is necessary to find a

suitable bioindicator to verify a respective model of explanation of the effect of high-frequency electromagnetic fields on human beings, especially on the human brainstructure.
To determine a possible bioindicator for an experimental physical interpretation of the model, we use topical studies about the learning process of honey bees (in a first step). In our model we assume that the knowledge of the honey bees' surrounding determine their actions. Thereby we suppose that this knowledge is caused by the information processing in the way described by the process of superation (Stever, 2002). This interpretation is supported by results of neurobiological research. It shows that the alterations of the honey bees' actions are combined with modifications in certain areas of their brain, especially in such areas called mushroom bodies (Withers et al, 1993; Faber & Menzel, 2001). Therefore we want to consider these mushroom bodies as representations of internal models, which were the results of honey bees' learning processes. These internal models represent parts of the surrounding. In addition, Menzel points out, that the associative brainstructure of bees is similar to the brainstructure of human beings: The memory of both passes through sequences, which differ in their susceptibility of problems and in the amount of participating brain areas (Menzel, 1993).
Summing up, these results show that honey bees are suitable for studying the neuronal basics of learning and memory. Furthermore honey bees turn out to be permissible and suitable bioindicators to develop adequate models of explanation for the effect of high-frequency electromagnetic fields on human beings, especially on the structure of their brain. Observations of honey bees also make it possible to develop corresponding theoretically guided models of effect, which are based on the theory of supersigns.

Methods

Physical design.

To study non-thermal influences of high-frequency radiation on the learning behaviour of honeybees, these insects (resp. their brains) had to be stimulated non-thermally (Stever & Kuhn, 2004). For that, we used the basis stations of cordless DECT mobile phones (Digital European Cordless Telecommunications). These stations send out continually electromagnetic radiation with a sending frequency $f_S \approx 1900$ MHz. So they also irradiate when the mobile phone is out of order or is not in use. The average transmitting power P_S amounts to 10 mW, the peak power is 250 mW. The sending signal is frequency modulated and pulsed with a pulsing frequency f_P of 100 Hz. The station was put at the bottom of a beehive, right under the honeycombs (Fig. 1).
The station was placed within the beehive, so the honey bees have been able to touch the sending aerial all the time.

Subjects and location.

The experiment was carried out on the premises of the "DLR Fachzentrum für Bienen und Imkerei" in Mayen by students of Environmental Sciences at the University of Koblenz-Landau/Campus Landau.
Subject was to study the behaviour of exposed and non-exposed honey bees concerning finding back home to the beehive and building honeycombs.

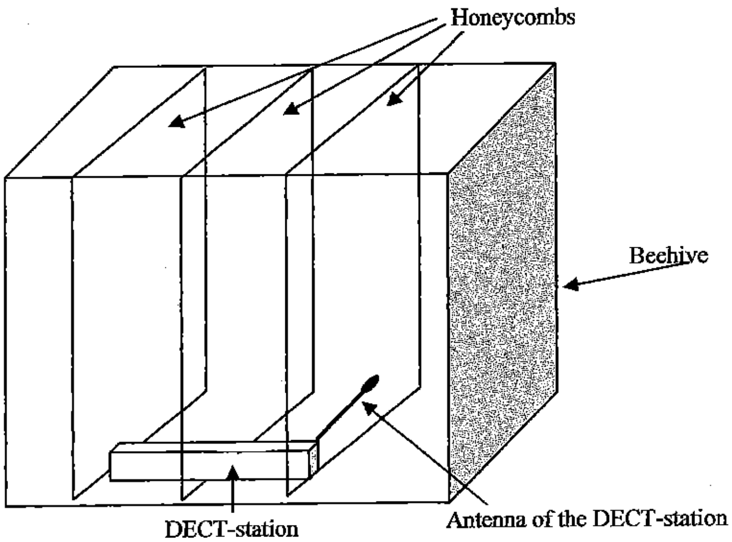

Fig. 1: Position of the DECT-station within a beehive.

Procedure.

Sight registration of returning behaviour to the beehive:

To study the returning behaviour eight mini-hives – each with colonies of about 8.000 individuals – were set up in a row. A block of four colonies were equipped with DECT-stations on the bottom of their hive. At the entrance of each hive a transparent 10 cm plastic tube with a diameter of 4 cm was mounted to gather single bees and watching them later entering the hive. At the beginning of each study-sequence 25 bees of one colony were gathered in their tubes, stunned in a cooling box and got marked with a marker dot on the thorax. At a distance of about 800 m to the hive all marked bees were set free simultaneously and got timed from that moment. The returning bees were intercepted at the bee hive's entrance and the returning time was noted down. The observation time lasted 45 minutes, bees that came back afterwards were disregarded. Within every study-sequence the groups of exposed and non-exposed honeybees were paired (at least one group of exposed and non-exposed colonies) and observed simultaneously.

Building behaviour:

To study the building behaviour of the bees, two variables were examined: the change of the honeycomb area, which was documented by photographs, and the development of the honeycomb weight. Sixteen mini-hive colonies, eight neighbouring hives with DECT-stations, were set up in a row. At the beginning of the experiment the empty frames for the honeycombs were weighed, then the hives got filled with bees (400 g) and 250 ml food. The bees were fed two times moreover while running the experiment. The front- and backside of the frames, six in each hive, with the developing honeycombs were photographed every day at the same time, also the frames got weighed.

Other data:

To register the returning behaviour of the bees automatically four standard hives, two of them with DECT-stations, were equipped with beescan-units. Because of technical problems and incompleteness, the data couldn't be taken into account. The collected weather data were incomplete, too.

Results

Because of the explorative character of this study we refrain from a differentiated statistical analysis, but exemplary the most obvious differences between exposed and non-exposed colonies about honeycomb weight and returning times will be represented graphically.
The development of honeycomb area and weight will be compared by averages of exposed and non-exposed colonies and shown in two diagrams, too.
The first two diagrams (Fig. 2 and Fig. 3) show the distribution of the averaged entire weight to single honeycombs of the respective experimental group. In the course of the experiment three exposed colonies and one non-exposed colony broke down. To compute the average weight of the honeycombs over all analyzed colonies their weight was used at the time of the breakdown.
While the weight of the frames for the honeycombs was similar at the beginning, the average total weights of the honeycombs, which were built by non-exposed bees, came to 1326 g while the average honeycomb weight of the exposed bees amount 1045 g. The difference of 281 g corresponds to 21.1%.

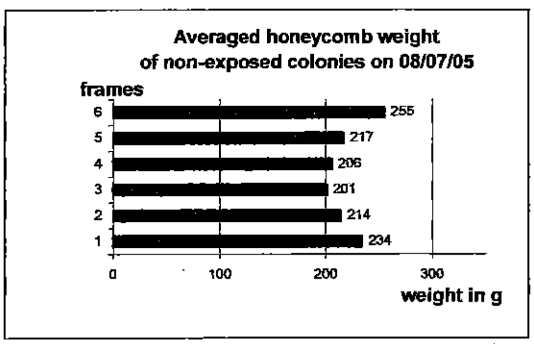

Fig. 2: Honeycomb Weight of non-exposed bees

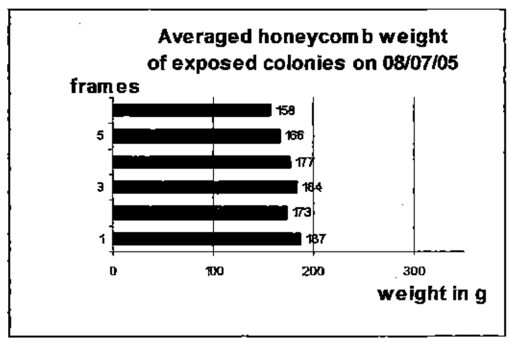

Fig. 3: Honeycomb Weight of exposed bees

Fig. 4 and Fig. 5 show the progression of honeycomb weight and area during the experiment. Right after the moment of the breakdown the data of the collapsed colonies were taken into account as constants. The area of the honeycombs couldn't be measured directly, so the photographs were analyzed with the graphic tool "ImageJ" (Rasband, 2005). With this software the area of the honeycombs could be marked by framing the section on the photos. Then the mean for front- and backside could be calculated to minimize errors determining the areas.
During the process of the experiment it became clear that both weight and area were developed better by non-exposed honey bees. Although this has to be interpreted as a tendency or a trend, a Mann-Whitney U-Test, which was done for descriptive reasons, never showed a difference (5%-level) between exposed and non-exposed colonies.
Fig. 6 - Fig. 9 depict the returning behaviour of a specific sequence of the experiment on 07/07/05, 12:10 to 12:55. All observed honey bees had the same weather conditions. These figures show that the quantity of returning bees of the non-exposed honey bees was bigger as well as the returning time of the few returning exposed honey bees was distinctly longer.

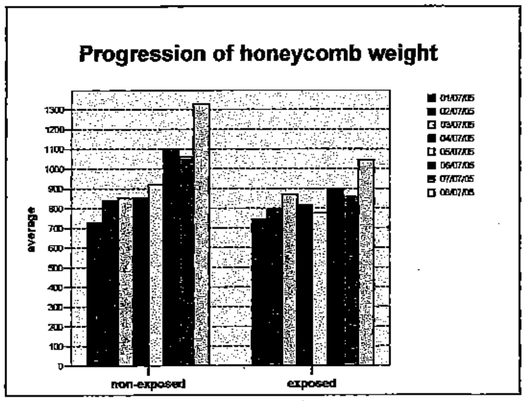

Fig. 4: Honeycomb Weight

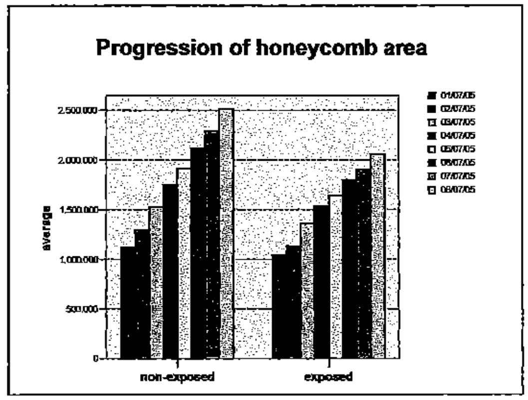

Fig. 5: Honeycomb Area

This observation was done during a sequence of the experiment with the maximum of returning bees of both exposed and non-exposed colonies. At no time of the experiment more than six exposed bees arrived, several times none came back to the hive within 45 minutes, whereas at every sequence of the experiment returning non-exposed honey bees could be observed. So the depict sequence shows even the best-case!

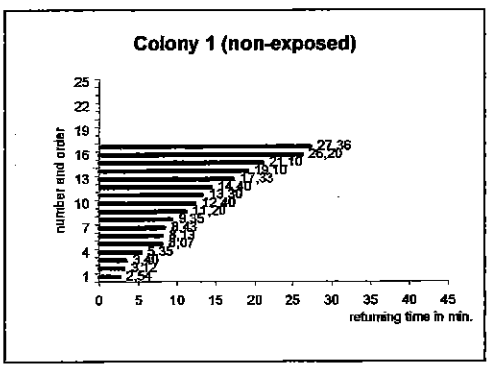

Fig. 6: Returning Time, Colony 1

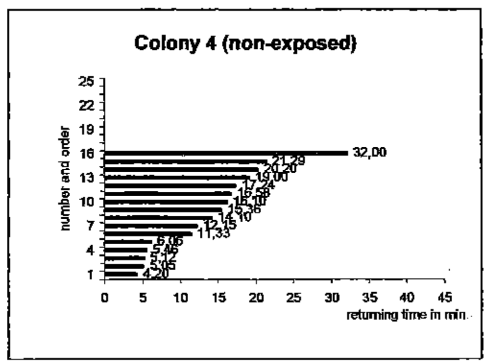

Fig. 7: Returning Time, Colony 4

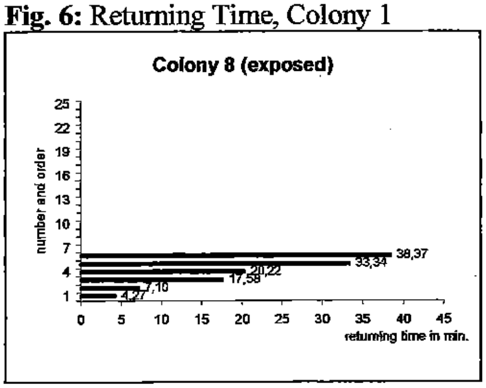

Fig. 8: Returning Time, Colony 8

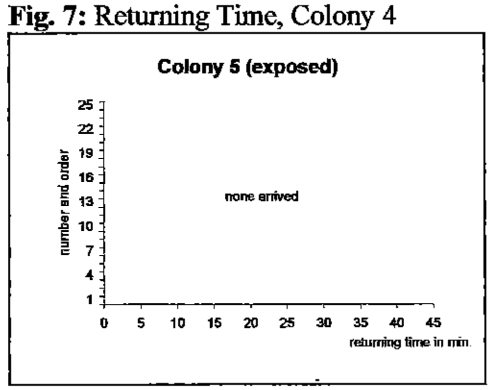

Fig. 9: Returning Time, Colony 5

Outlook

The physical design of this study could be modified in different ways concerning the used power and frequency. Therefore mostly frequency- and power-ranges of daily life should be interesting. So the following physical modifications are conceivable:

1. Increasing power:
   In a worst-case-study the DECT-station should run in active state with maximum sending power.
2. Frequency-modification:
   Besides cordless DECT phones, which are mostly used within buildings, other mobile phones could be used. For example the GSM mobile phones (Global System for Mobile Communication) send their information with sending frequencies of 900 MHz and 1800 MHz as well as with a pulsing frequency of 217 Hz. So GSM mobile phones differ from DECT-phones in their physical characteristics, these phones can also be used in buildings as well as outdoors. Because GSM technology works with power adjustment depending on the distance between mobile phone and station, the phone should be used in active process for worst-case-situation.

Further modifications could be done regarding to the position of the beehives and the periods of exposition. To reduce location-effects the control- and experimental beehives should be positioned alternately. Furthermore the period of exposition and studying the honeybees' behaviour could be modified or extended. In order to that different stages of bee development (not only the adult level) and the influence of exposition in each stage could be observed.

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Attachment 15

EM Exposure Impact on Bee Behavior by Sharma & Kumar

Changes in honeybee behaviour and biology under the influence of cellphone radiations

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Increase in the usage of electronic gadgets has led to electropollution of the environment. Honeybee behaviour and biology has been affected by electrosmog since these insects have magnetite in their bodies which helps them in navigation. There are reports of sudden disappearance of bee populations from honeybee colonies. The reason is still not clear. We have compared the performance of honeybees in cellphone radiation exposed and unexposed colonies. A significant ($p < 0.05$) decline in colony strength and in the egg laying rate of the queen was observed. The behaviour of exposed foragers was negatively influenced by the exposure, there was neither honey nor pollen in the colony at the end of the experiment.

Keywords: Colony strength, electromagnetic field, foraging behaviour, honeybees.

RECENTLY a new phenomenon of sudden disappearance of bees with little sign of disease or infection has been reported from the world over. Bees simply leave the hives and fail to return[1,2]. Colony collapse disorder (CCD) is the name given to this problem. Bee colony collapse was previously attributed to viruses, parasitic mites, pesticides, genetically modified crop use and climate change. On the basis of widely reported influences on honeybee behaviour and physiology, electromagnetic field is emerging as a potent culprit[3].

The decimation of bees is seen as a grave risk to the delicate equilibrium of the ecosystem. There is an urgent need to understand the complicity of interaction involved in the influence of electromagnetic radiations particularly due to cellphones on honeybee biology and to work out a strategy of development with minimal environmental implications.

Four colonies of honeybees, *Apis mellifera* L, were selected in the apiary of the Zoology Department, Panjab University, Chandigarh. Two colonies T_1 and T_2 were marked as test colonies. These were provided with two functional cellphones of GSM 900 MHz frequency. The average radiofrequency (RF) power density was 8.549 $\mu W/cm^2$ (56.8 V/m, electric field). The cellphones were placed on the two side walls of the bee hive in call mode. Electromotive field (EMF) power density was measured with the help of RF power density meter (Figure 1).

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Blank colony (B) was equipped with dummy cellphones, while the control colony (C) had no cellphones.

The exposure given was 15 min, twice a day during the period of peak bee activity (1100 and 1500 h). The experiment was performed twice a week extending over February to April and covering two brood cycles.

The following biological aspects were recorded during observations.

Brood area: The total area under brood comprising eggs, larvae and sealed brood was measured in all the experimental colonies with the help of a 1 sq. cm grid mounted on a comb frame[4].

Queen prolificacy: This was measured in terms of egg laying rate of the queen. In order to determine the number of eggs laid by the queen per day, the total brood area measured was multiplied by a factor of 4 to calculate the total number of cells containing the brood (there are 4 cells per sq. cm of comb). This number was divided by 21 (as the average time taken for an egg to change into an adult worker is 21 days) to get the egg laying rate of the queen[5].

The queen prolificacy was calculated as:

$$QP = \frac{\text{Total brood area (cm}^2) \times 4}{21}.$$

The following behavioural aspects were observed.

Foraging: (i) Flight activity measured as number of worker bees leaving the hive entrance per minute: before exposure and during exposure. (ii) Pollen foraging efficiency measured as number of worker bees returning with pollen loads per minute: before exposure and during exposure. (iii) Returning ability determined by counting the

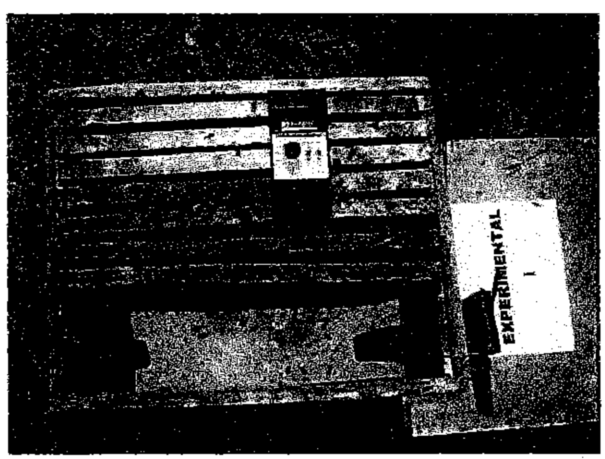

Figure 1. Experimental colony showing placement of mobile phones and power density meter.

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Table 1. Changes in foraging behaviour of *Apis mellifera* exposed to cellphone radiations

Parameter	Control (mean ± SD)	Treated (15 min exposure) (mean ± SD)
Flight activity		
(No. of workers bees leaving the hive entrance/min)		
Before exposure	35.9 ± 13 (12–61)	34.1 ± 10 (18–48)
During exposure	37.2 ± 12 (12–72)	22.8 ± 6 (13–34)
Returning ability		
(No. of worker bees returning to the hive/min)		
Before exposure	39.6 ± 13 (12–61)	36.4 ± 11 (21–58)
During exposure	41.3 ± 11 (14–78)	28.3 ± 8 (16–48)
Pollen foraging efficiency		
(No. of worker bees returning with pollen loads/min)		
Before exposure	7.0 ± 2 (4–9)	6.3 ± 2 (4–10)
During exposure	7.2 ± 2 (4–11)	4.6 ± 2 (2–7)

Table 2. Changes in colony status of *Apis mellifera* exposed to cellphone radiations

Parameter	Control (mean ± SD)	Treated (15 min exposure) (mean ± SD)
Bee strength		
Start	7 frame	7 frame
End	9 frame	5 frame
Brood (cm^2)		
Total brood		
Start	2033.76 ± 182.6 (7–532)	2866.43 ± 169.0 (0–574)
End	1975.44 ± 138.8 (0–427)	760.19 ± 111.0 (0–348)
Prolificacy (egg laying rate/day)		
Start	387.24	545.9
End	376.20	144.8
Honey stores (cm^2)	3200	400
Pollen stores (cm^2)		
Start	230.5 ± 21.60 (198–305)	218.2 ± 17.48 (141–241)
End	246.7 ± 16.94 (195–289)	154.7 ± 7.30 (142–168)

number of worker bees returning to the hive per minute: before exposure and during exposure.

Colony growth: (i) *Bee strength*: measured as total number of bee frames per colony. (ii) *Honey stores*: the area containing ripe and unripe (sealed and unsealed) nectar was measured in sq. cm with the help of the grid[4]. (iii) *Pollen stores*: the portion of comb containing cells filled with stored pollen was measured by the grid method. It was expressed in sq. cm.

The results of the studies carried out on biological and behavioural aspects of the colonies exposed to cellphone radiations for a duration of 15 min are presented in Tables 1 and 2.

It was observed that the total bee strength was significantly higher in the control colony being nine comb frames as compared to only five in the treated colony at the end of the experiment. There were no dead bees in the vicinity of the hive which is a characteristic of this disorder reported by other workers[9,10]. The area under brood declined to 760.19 cm^2 which was significantly less than the control (1975.44 cm^2).

The queen exposed to cellphone radiations produced fewer eggs/day (144.8) compared to the control (376.2). It has previously been reported that there is queen loss in colonies exposed to high voltage transmission lines[11] or exposure of the queen bee to cellphone radiations stimulated her to produce only drones[12].

The number of returning bees declined. Another important finding was that the number of bees leaving the hive also decreased following exposure (Table 1). There was no immediate exodus of bees as a result of this interference, instead the bees became quiet and still or confused as if unable to decide what to do. Such a response has however not been reported previously.

As the total number of returning bees decreased (28.3 bees/min) so did the number of pollen foragers returning to the hive (4.6). This led to decrease in the area

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under pollen stores from 246.7 cm^2 in control to 154.7 cm^2 in the treated colonies.

The honey storing ability declined due to loss of returning bees and at the end of the experiment there was neither honey, nor pollen or brood and bees in the colony resulting in complete loss of the colony. Similar conditions have been observed by other workers in case of honeybees under the influence of high tension lines[13–15]. Bee hives located near high voltage power lines in fields as low as 4 Kv/m produced less honey and had high mortality rates. It was also observed that colonies exposed to strong electric fields produce less honey[16]. The present study therefore suggests that colony collapse does occur as a result of exposure to cellphone radiations.

Reports of such a colony collapse in nature in developing countries like India where electromagnetic radiation (EMR) based technologies are comparatively new are absent. It is possible that the electrosmog that prevails in the advanced countries of the world has not yet affected these countries. We are fortunate that the warning bells have been sounded and it is for us to timely plan strategies to save not only the bees but life from the ill effects of such EMR.

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Impact of tuna longline fishery on the sea turtles of Indian seas

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Longline fishery is exerting an impact on the sea turtle populations of the seas around India, as in the case of many longline fisheries operating in other parts of the world. During the tuna longline survey conducted by four research vessels of Fishery Survey of India, 87 sea turtles were caught incidentally from the Arabian Sea, Bay of Bengal and Andaman and Nicobar waters of the Indian exclusive economic zone (EEZ) during 2005–08, registering an overall hooking rate of 0.108 turtles per 1000 hooks operated. There were marked differences in the hooking rates of turtles recorded from these three regions of the Indian EEZ, the maximum hooking rate being recorded from the Bay of Bengal (0.302), followed by the Arabian Sea (0.068) and Andaman and Nicobar waters (0.008). The species of sea turtles recorded in the bycatch, in order of abundance, were olive ridley (*Lepidochelys olivacea*), green (*Chelonia mydas*) and hawksbill (*Eretmochelys imbricata*) turtles. This study provides quantitative data on the magnitude of sea turtle incidental catch of the tuna longline fishery in the Indian EEZ.

Keywords: Arabian Sea, Andaman and Nicobar waters, Bay of Bengal, hooking rate, longline.

SEA turtles are among the most extraordinary, charismatic and fascinating creatures, and are some of the world's greatest nomads, sometimes navigating thousands of miles between feeding and nesting grounds. Six of the

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Attachment 16

CT Audubon Protecting CT Grassland Heritage

Audubon CONNECTICUT

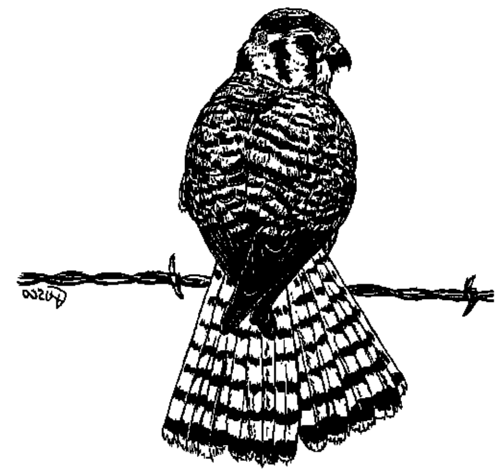
Protecting Connecticut's Grassland Heritage

A Report of the Connecticut Grasslands Working Group
April 2003
Revised January 2005

Appendix III

	50% Incidence	Min. Area	Territory Size	Vegetation Type	Grassland Type
Henslow's Sparrow	55 ha (135 acres) (Herkert, 1991)	NA	0.3-0.8 ha (0.75-2 acres)	Tall, dense grassy vegetation with scattered, tall forbs, and residual dead vegetation.	Grassy meadows, wet meadows, grassy edges of wetlands, and shrub-sprinkled, grassy uplands.
Bobolink	10-30 ha (25- 75 acres); densities decline if <30 ha (75 acres) (Martin and Gavin, 1995)	2-4 ha (5-10 acres)	0.4-2.4 ha (1-6 acres)	Mixed grass (ht: 8-12"), old hayfields > 8 years old with relatively sparse ground cover, usually in lowlands with moist soil; prefer mosaic of grasses, sedges and scattered broad-leaved forbs with <25% shrub cover; use shrubs, posts, small trees as song perches.	Upland meadow/pasture, wet meadow, old field (e.g., old hayfields, reclaimed grasslands, capped landfills).
Eastern Meadowlark	<10 ha (25 acres); area from Herkert (1991), did not reach 50% incidence in Vickery study;	6-8 ha (15-20 acres)	2.4-3.2 ha (6-8 acres)	Sparse to dense grass-dominated cover (ht:10-20"), preferably in low-lying areas with damp soils, thick layer of dead grass, scattered shrubs (ht:1-8'), and tall forbs (ht:1-15") for song perches; prefer mixed grass fields to alfalfa.	Upland meadow/pasture, old fields (e.g., hayfields, croplands, reclaimed grasslands and capped landfills, airports, shrubby overgrown fields).
Northern Harrier	NA	Uncommon in blocks of contiguous grassland <100 ha (250 acres) in North Dakota (Dechant et al., 1998).	Varies (MacWhirter and Bildstein, 1996).	Nests on ground in dense vegetation at edges of extensive open areas (Dechant et al., 1998).	Open wetlands, including marshy meadows; wet, lightly grazed pastures; freshwater and brackish marshes; upland prairies and mesic grasslands (MacWhirter and Bildstein, 1996).
American Kestrel	NA	NA	111-207 ha (275-512 acres) in MI and WY (Weidensaul, 2000).	Any area with suitable nesting cavities, adjacent to open areas with suitable perches for hunting (Weidensaul, 2000).	For nesting requires nest boxes or natural cavities at edges of extensive grassland or open agricultural areas. Grasslands or shrubland at the edge of forest or open country. Agricultural areas, airports, large parks, power line rights of way (Weidensaul, 2000).

American Kestrel
Between the 1980s and 2001 the nesting population of this species has declined dramatically in Connecticut. The Connecticut Breeding Bird Atlas (1982-86) lists 78 confirmed nesting locations and 101 probable locations. Grassland bird surveys conducted by the Connecticut Ornithological Association in the summer of 2001 found only 10 suspected nesting locations. Kestrels require cavities (either natural or nest boxes) positioned at the edges of extensive grasslands, agricultural areas, or other open habitats. Connecticut lists it as threatened. Nest box programs should be instituted in suitable grassland habitat and agricultural areas, especially those where kestrels have been seen during the breeding season in recent years. A recovery goal of 128 nesting pairs of kestrels would restore the population to 1980s levels. This estimate assumes that ~50% of the probable nesting locations recorded during the Breeding Bird Atlas Project were actually occupied by nesting birds, and that there was only one pair at each site where breeding was confirmed.



Barn Owl
This species is not strictly a grassland-nesting species, but certainly benefits from the presence of large grasslands and other open areas. It requires nest boxes, abandoned buildings, natural cavities or other enclosed shelter at the edges of extensive grasslands, wastelands, agricultural lands, or other open areas. Barn Owls are listed as endangered by the State of Connecticut and would benefit from the continuation and expansion of current nesting box programs, the creation of more grassland habitat, and farmland preservation.

Attachment 17

Natural Diversity Data Base Area - Watertown Map

Natural Diversity Data Base Areas

WATERTOWN, CT

July 2011

State and Federal Listed Species & Significant Natural Communities

Town Boundary

NOTE: This map shows general locations of State and Federal Listed Species and Significant Natural Communities. Information on listed species is collected and compiled by the Natural Diversity Data Base (NDDB) from a number of data sources . Exact locations of species have been buffered to produce the general locations. Exact locations of species and communities occur somewhere in the shaded areas, not necessarily in the center.

This map is intended for use as a preliminary screening tool for conducting a Natural Diversity Data Base Review Request. To use the map, locate the project boundaries and any additional affected areas. If the project is within a shaded area; or over-lapping a lake, pond or wetland that has shading; or upstream or downstream (by less than 1/2 mile) from a shaded area, the project may have a potential conflict with a listed species. For more information, complete a Request for Natural Diversity Data Base State Listed Species Review form (DEP-APP-007), and submit it to the NDDB along with the required maps and information. More detailed instructions are provided with the request form on our website.

www.ct.gov/dep/nddbrequest

This file has PDF Layers. Look for the Layers tab on the left. Expand the layers and use the "eye" icons to change visibility.

QUESTIONS: Department of Energy and Environmental Protection (DEEP)
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Phone (860) 424-3011

Connecticut Department of Energy & Environmental Protection
Bureau of Natural Resources
Wildlife Division