Environment and Natural Resources Trust Fund

Research Addendum for Peer Review

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Project Title: **Mitigating Pollinator Decline**

Project number: **LCCMR 221-G**

1. Abstract

Research will investigate the accumulation of systemic insecticides in nectar and pollen on mortality and behavior of pollinators. Systemic insecticides are applied to the soil, absorbed by the roots, and distributed throughout the plant. Recently, these insecticides were suggested as one factor behind Colony Collapse Disorder (CCD), which is causing enormous loss of honey bees. Also, bumble bees are in decline, which may be due to insecticides used in landscapes.

Systemic neonicotinyl insecticides, such as imidacloprid, are banned in Germany and France for use on corn and canola seed, since the chemical was translocated from seed to nectar and pollen and altered behavior and killed honey bees. In the US, imidacloprid is applied to landscape plants at extremely high rates and when the plant is flowering so more chemical is moved to nectar and pollen. Besides our preliminary work at the University of Minnesota, research has not investigated the contribution of these higher levels used in landscapes on pollinator decline.

Outcomes of research are to mitigate pollinator decline by the development of landscape management recommendations that use insecticides that do not kill pollinators for managing pest insects. Also, for urban landscapes a list of pollinator-friendly plants that provide food throughout the season will be developed through research. Talks, workshops, bulletins, and website on promoting pollinators will be delivered to homeowner and professional communities to help save pollinators. An advisory committee composed of representatives from state agencies, landscapers, bee keepers, and commodity associations will help advise the research and outreach programs.

2. Background

Native plants used in restoration for wildlife and food plants from apples to zucchini require pollinators. Bees and other pollinators offer valuable ecosystem services in both natural and managed agriculture ecosystems, so it is essential to protect them. Pollinators are experiencing serious decline due to insecticide use, lack of nutritionally rich native plants for pollen and nectar, and lack of habitat. Continued loss of pollinators will have an impact on the natural resources and the economy of Minnesota.

This issue has been addressed by the Xerces Society, National Research Council Report, the Congressional Research Report, testimony by the National Academy of Sciences to the US Congress, and the media in newspapers and television programs. For the first time a group at Pennsylvania State University are investigating Colony Collapse Disorder (CCD) and what weakens bees, such as the interaction of *Varroa* mites, insecticides, fungus, and virus in the hive. However, systemic neonicotinyl insecticides used on landscape plants and crops are considered as a major factor in pollinator decline. After the 1998 ban in France of the systemic seed treatment Gaucho (active ingredient, imidacloprid), French researchers found that imidacloprid is translocated from coated seeds at planting thru the growing plant to nectar and pollen in flowers. In May 2008 a large number of bees died in Germany and the government banned the use of 5 neonicotinyl insecticides, including imidacloprid and clothianidin.

However, in the US use of these 5 neonicotinyl insecticides is very common in greenhouse, landscape, and crops. Native plants grown in greenhouses and transplanted outside may contain high levels of imidacloprid which may kill pollinators. Research in France on the seed treatment Gaucho used in corn, sunflower, and canola demonstrated that imidacloprid was translocated to nectar and pollen. Our research demonstrated that nectar and pollen from greenhouse plants treated with soil applications of imidacloprid contained significantly higher amounts of imidacloprid and its metabolites, than from a Gaucho-seed treatment. The label of Gaucho states that 0.375 mg AI for corn and 0.11 mg AI of for canola of imidacloprid should be applied. The greenhouse rate used on perennial landscape plants states that 300 mg AI/ 3gallon pot with 1 plant can be used. This is an 800 times higher rate for corn and 2700 times higher rate for canola. Consequently, greenhouse and urban landscapes use higher concentrations of imidacloprid, which are often reapplied and used at peak flowering, which results in higher concentration being translocated directly to flowers. Consequently, these levels have great potential to alter behavior or kill pollinators and beneficial insects more than the seed treatment Gaucho where most of the research has been done.

Our research on greenhouse rates of imidacloprid showed that the amount of imidacloprid found in nectar of 2 flowering plants was 20 ppb to 41 ppb from a single soil application compared to 1.9 ppb imidacloprid in sunflower nectar and 0.6 to 0.8 ppb in canola nectar from a seed treatment. For buckwheat and milkweed landscape plants, a label rate of soil applied imidacloprid (Marathon 1%G) was translocated to buckwheat nectar at 16 ppb (Krischik et al. 2007) and milkweed at 41 ppb/flower (Krischik et al. 2010). These concentration of caused high mortality of beneficial insects, such as lady beetles, lacewings, and a small parasitic wasp (Smith and Krischik 1990, Rogers et al. 2007, Krischik et al. 2007, Krischik et. al 2009 submitted).

There are multiple ways that plants in urban landscapes can contain imidacloprid -contaminated nectar, since it is commonly applied in the landscape for many pests (Krischik and Davidson 2004) and many greenhouse plants are treated with prior to sale and transplanting. Imidacloprid may persist in nectar for a long time, since soil applications were effective against foliar pests for 1 to 2 years in containers (Szczepaniec and Raupp 2007, Gupta and Krischik 2007, Tenczar and Krischik 2007) and landscape trees (Cowles et al. 2006, Frank et al. 2007, Tenczar and Krischik, 2007). Injections of concentrated volumes of imidacloprid (Imicide, Pointer) applied to trees trunks and roots were effective for 12 months for ash (McCullough et al. 2003) and linden (Johnson and Williamson 2007). Tree injections of imidacloprid at flowering are cause for concern, since linden flowers are a good source of nectar and pollen for bees, butterflies, and other beneficial insects.

However, the effect of these higher levels of imidacloprid used on landscape plants on bees has not been researched. Please see Table 1 for information on how much imidacloprid and clothiaindin can alter behavior or kill bees.

3. Hypothesis
Research result 1. Investigate whether systemic insecticides, imidacloprid and clothianidin, are translocated to nectar and pollen in sufficient amounts to kill or alter behavior of pollinators.
Deliverable 1. We will mitigate pollinator loss by developing a section on the CUES website on "Pollinator compatible insecticides for landscapes." We will amend the 2004 "IPM of Midwest Landscapes" that is online at the CUES website to contain a section on pollinator compatible insecticides (http://www.entomology.umn.edu/cues/ipmbook.htm).We will mitigate pollinator loss by developing landscape pest management protocols using pollinator-friendly insecticides.

Research result 2. We will determine the best plants to be used in Minnesota landscapes to provide season-long nectar and pollen for pollinators. Most plant recommendations are derived from published lists that were not based on research. When you study these recommended plants in the field, many are not visited by bees or beneficial insects.
Deliverable 2. We will mitigate pollinator loss by developing a section on the CUES website on "Mitigating pollinator loss through proper plant selection" as we did for the collaborative plant restoration project with the Washington-Ramsey Watershed District and DNR http://www.entomology.umn.edu/cues/gervais/gv_links.htm). We will mitigate pollinator loss by developing recommendations for restorations and landscapes with seasonal phenology of pollinator plants.

Deliverable 3. We will create an advisory panel with stakeholders and meet every 4-8 mo to discuss research and outreach projects. We will provide 4 workshops per year, a total of 12 for the grant period, to professionals, state agencies, commodity groups, and homeowners on conserving pollinators. We will provide articles and talks in established outreach events, such as MDA Pesticide Applicator Training, MNLA (MN Nursery and Landscape Association) Certification Events, Watershed Events, and others. We will post the bulletins, posters, and recommendations on the CUES (www.entomology.umn.edu/cues) an UM honeybee (www.extension.umn.edu/honeybees) to disseminate information.

Table 1. Level applied for commodities and level detected in nectar		
Commodity	***(AI) treatment rate***	***residue in nectar (research paper)***
Seed treatment Gaucho* *most research on this treatment level	0.11 mg /plant	0.6-0.8 ppb canola nectar (Scott-Dupree and Spivak 2001) 1.9 ppb sunflower nectar (Schmuck et al. 2001) 6 ppb found in bee pollen loads in France (Chauzat et al. 2006)
field crops most formulas Admire Pro,etc	4 mg/sg ft	**not researched**
Greenhouse/nursery pots before planting outdoors; can reapply	300 mg /3galpot	20 to 54 ppb (Krischik et al. 2007, 2009)
3 ft plant in landscape, rose	630 mg	**not researched**
?DBH apple tree-method? ?DBH eucalyptus-method? 16 in DBH tree-soil drench 24inDBH tree- soil drench	unknown unknown 50 g AI 76 g AI	4000 ppb unpublished, Bayer 550 ppb, unpublishedTim Payne, UCRiverside **not researched** **not researched**
Levels that alter behavior or kill pollinator or beneficial insect (passive pollinators)		
Insect species	***Level***	***Research paper***
Greenhouse research Kills beneficial insects: ladybeetle predator (4 sp), green lacewing predator, parasitic wasp	15 ppb	(Krischik et al. 2007, 2009)
Kills honeybees **in one sip** **NOEC** **actute oral** **acute contact**	 **158-185 ppb** **<5ppb** **40 ng/bee** **40-102 ng/bee**	(Bayer report 2007) (PAN-Europe 2009 letter) (Suchail et al 2001) (Nauen 2001)
Level altering honeybee behavior	6-100 ppb	24 ppb disrupts learning & olfactory conditioning (Decourtye et al. 2004) 6 ppb disruption of feeding (Colin et al. 2004) 100 ppb decrease in foraging (Kirchener 1999)
Level altering bumblebee behavior *B. impatiens* *B. terrestris* *B. impatiens*	10-30 ppb .	30 ppb slower foraging rate (Morandin and Winston 2003) 10 ppb reduced brood survival (Tasei et al. 2000) clothianidin, and thiamethoxam are deadly at extremely low dosages (Biobest 2008)
Kills honeybees **acute oral**	**43 ng/bee** **clothianidin**	US EPA Clothianidin Factsheet Clothianidin (Arena) is a major metabolite of thiamethoxam which is also labeled for landscape (Flagship- flowers, Meridian-turf)

4. Methodologies

Research result 1. Investigate whether systemic insecticides are translocated to nectar and pollen in sufficient amounts to kill or alter behavior of pollinators. We will study the amount of systemic neonictoinyl imidacloprid that is translocated to nectar and pollen from a soil application of imidacloprid (Merit) on rose, dandelion, and small linden trees. We will use residue analysis to determine the parent compound and metabolites in nectar and pollen. For clothianidin, we will only determine amounts of parent compound and metabolites in pollen of rose from a soil application (Arena), due to costs and time. We will not bioassay with insects, since the LD50 are very close for imidacloprid and clothianidin. We will use a residue analysis lab since it is cost effective and we have used this lab for past research (ALS Laboratory Group, www.alsenviro.com, Environmental Division, Edmonton, Canada). We will determine the effects of these levels of imidacloprid on behavior and mortality of beneficial insects, honey bees and bumble bees.

We will plant dandelion, rose, and linden trees in field plots at the University of MN, St Paul Campus. For dandelion and rose, the imidacloprd treatments will include: 1) control, 2) 1X landscape rate soil application, and 3) 2X landscape soil applications since labels permit reapplication. For linden trees, the treatments will include: 1) control, 2)1X soil drench, 3) 1X trunk injection, and 4) 2X trunk injection. We will replicate the study 3 times. We will use 21.4% A. I., Merit 2F, Bayer Chemical Co. For clothianidin (Arena) we will use the treatments as outlined above on rose.

We will collect open flowers at mid-day, at the height of nectar production, from approximately 30 different plants, for a mean of 65 flowers per 10-ml scintillation vial and will place the collected flowers in a cooler filled with ice. The vials will be stored in an ultralow freezer at -79°C.

Residue analysis. We will determine the concentration of , olefin, and hydroxy translocated to nectar and pollen both in flowers and collected by bees by Liquid Chromatography-Mass Spectrometry residue analysis as we did in our prior research (Krischik et al. 2007 and Krischik et al. 2009 submitted; and others, such as Laurent and Rathahao 2003). This residue analysis will be conducted by ALS Laboratory Group, Environmental Division, Edmonton, Alberta, Canada, which has performed our residue analysis on 2 plant species for imidacloprid. They can also perform residue work on clothianidin, although that analysis is not outlined here.

For residue analysis, each sample of 1.0 g of pollen or nectar (approximately 200 flowers combined from at least 3 vials) will be placed in 15 ml of water in a 50 ml culture tube, followed by an ultrasonic bath for 2 min, then placed on a wrist shaker for 2 hr, filtered, partitioned with dichloromethane, filtered, and evaporated to dryness. The residue will be dissolved in 20% acetonitrile/0.1% acetic acid and brought to 1 ml, frozen, and then extracted with acetonitrile and concentrated with a rotovaporator. The samples will be analyzed by Liquid Chromatography-Mass Spectrometry LC/MS (PE Sciex API 3200 or 4000 Q-trap system) with variant solvent delivery system, and Agilent Automatic Sample Injector. The operating conditions are a YMC-ODS-AM column, 5 µm particle size, 40 ºC, mobile phase A 0.1% acetic acid in water and mobile phase B 0.1% acetic acid in acetonitrile, flow rate 0.5 ml/min, and injection volume 15 µl. Gradient is 0 min 90% A, 10% B: 6.5 min 30% A, 70% B; 8.0 min 50% A, 50% B; 13 min 90% A, 10% B.

The standards will be purchased from Bayer CropSciences (Research Triangle Park, NC) (lot no. 0625200305, purity 99.2%; hydroxy lot no. 072620061 purity 96.8%; olefin lot no. 12192000301, purity 79.8%). The spiking standards were prepared in 20% acetonitrile/0.1% acetic acid. Samples were fortified with imidacloprid, hydroxy, and olefin at 0.05 and 0.10 ppm. Retention time was 7.75 min for imidacloprid (mass transition 256.6 to 209.0), 7.36 for hydroxy (mass transition 272.0 to 225.0) and 7.24 min for olefin (mass transition 254.0 to 207.0). The limit of quantification for imidacloprid, hydroxy, and olefin was 0.05 ppm based on a 1.0 g sample and final volume of 1.0 ml. The average recovery of imidacloprid, hydroxy, and olefin was 95%, 74%, and 96% respectively at 0.05, 0.10, and 15 ppm.

Statistical Analysis. For all research, we will first use Levene's test to determine homogeneity of variance. If variances are unequal, a Welch test will be used (JMP, SAS 2005). If variances are equal, data will be analyzed with one way ANOVA for treatment, replicate and replicate by treatment interactions using PROC GLM (SAS 2004). Means will be compared with Tukey's HSD test. We will use PROC MIXED for any data that needs repeated measures statistics (SAS 2004).

Determine the effects of direct applications of imidacloprid on the behavior and survivorship of pollinators.

Behavioral observation of beneficial insects. Beneficial insects, green lacewing (*Chrysoperla carnea*, 1 species of wasp (*Anagyrus psuedococci*), and 3 species of lady beetles (*Harmonia axyridis*, *Hippodaemia convergens*, *Coleomegilla maculata*) will be ordered from Roncon Vitova Insectaries (Ventura, CA) or field-collected. Procedures developed by Krischik et al (2007, 2009) will be followed. Mesh cages (30 cm × 30 cm × 30 cm) (BioQuip, Rancho Dominquez, CA) will be daily supplied with cut flowers and water. When insects are received and prior to the study they will be conditioned with commercial artificial diet for lacewings and lady beetles (Rincon-Vitova) and 20% honey-water for all species (Aquatube, Syndicate Sales, Kokomo, IN). For 2 weeks, mortality and trembling will be observed 2X daily. Flowers from field studies will be used. At least 10 cages for each treatment will be used and the experiment will be replicated 3 times.

Behavioral observation of individual bees. We will obtain commercially purchased bumble bee colonies from Koppert Biological Systems (Romulus, Michigan). Koppert supplies *Bombus impatiens* colonies for greenhouse pollination of tomatoes; therefore colonies in any stage of their annual life-cycle can be purchased year round. We can easily rear *B. impatiens*, but due to facility constraints, can only initiate colonies during their normal colony life cycle in MN, between June and late August.

We will follow published protocols to study the effects of on the behavior and survivorship of bumble bees (Regali and Rasmont 1995, Tasei et al. 2000, Babendreier et al. 2008). Starting year one (Fall 2009) we will determine if bumble bees can detect dissolved in sucrose solution, and we will quantify the number and duration of visits to the feeders as a correlate of effects of foraging behavior (Babendreier et al 2008). Thirty large (forager) bumble bee workers from each of four colonies will be individually tagged on the thorax (using commercially available tags for honey bees). The colonies with marked bees will be placed in cages within a greenhouse maintained at 25°C with a 16 light:8 dark phtoperiod. Sugar syrup (50% wt/vol) will be provided in feeders within the cage. After several days, the sucrose solution in the cages will be spiked with imidacloprid; one colony will be treated at 20 ppb (published concentration that affects bee behavior), a second colony with 40 ppb (concentration found in milkweed nectar), and a third colony at 400 ppb (high dose) (Bayer Chemical Co, Analytical Grade). The fourth colony will serve as a control and the sucrose will not be spiked. Food solutions will be provided *ad libitum* and feeders will be weighed and replaced daily. In addition, 3.5 g of mixed floral pollen (collected from honey bee colonies and stored frozen) will be provided daily in a Petri dish placed in front of the hive entrance. Four observation periods will be conducted each day to record each visit and duration of a marked bumble bee at the feeder. The experiment will last for 5 days. The experiment will be repeated three times, using new hives for each replicate. Repeated measures ANOVA will be used to analyze differences in number and duration of bee visits to the feeders across the treatments. In year 2 and 3, these behavioral observations may be repeated using concentrations derived from field studies.

Effects of imidacloprid on bumble bee learning. One bioassay commonly used to study learning in bees, and the effects on learning from pesticides or immune challenges, is a classical conditioning paradigm based on the proboscis-extension reflex (Bitterman et al., 1983; Laloi et al., 1999; Masterman et al. 2001). In brief, an individual bee is harnessed in the laboratory and an odor is passed across the bees' antennae. While the odor is being presented, a drop of sucrose solution is touched to one antenna of the bee, which elicits an automatic proboscis-extension response, or PER. The sucrose is then fed to the bee as a reward. After several presentations of the odor (the conditioned stimulus, CS) followed by the sucrose (unconditioned stimulus, US), the bee learns to anticipate the US upon presentation of the CS alone. M. Spivak and students have published numerous studies on the use of PER learning in honey bees (e.g., Masterman et al., 2001) and all equipment is available in her lab. Here, we propose to use PER on *B. impatiens*, to study the effects of imidacloprid on learning in bumble bees, which will serve to quantify sub-lethal effects of imidacloprid on these bees.

After the experiments are finished on the colonies used in the greenhouses (above), tagged bumble bees known to have fed on the imidacloprid solutions, will be collected and harnessed in plastic tubes in the laboratory. Only bees that display a PER response to sucrose will be used in learning trials. After the trials, the bees will be returned to their colonies and will not be tested again. We will compare the bee's acquisition (learning curve) to the presentation of linalool, a floral odor, as the CS over 8 presentations of the CS for 12 seconds (with a 15 minute inter-trial interval). Depending on the results of the acquisition trials, we can continue with studies of extinction (to quantify memory) and discrimination. (Bitterman et al., 1983; Matserman et al., 2001).

Effects of imidacloprid on bumble bee health. In this study to be conducted over 2 years, we will use micocolonies of bumble bees following previously established methods to measure lethal and sublethal effects of insecticides on bumble bees (Regali and Rasmont 1995; Tasei et al, 2000; Babendreier et al, 2008). Microcolonies of *B. impatiens* will be established by placing three newly emerged bumble bee workers in wooden boxes. Within a few days, a hierarchy will be established and one dominant worker in each microcolony will develop her ovaries and lay eggs. The eggs of these uninseminated false queens will develop into haploid male progeny. The two other workers will care for the male brood of the false queen, allowing us to quantify brood care. All male offspring reared from the worker's colonies will be removed at the day of emergence and stored at –20C.

Bees will be provided with a feeder containing sucrose solution spiked with concentrations of imidacloprid (Bayer Chemical Co, Analytical Grade), 0, 20, 40, 400 ppb in year 1, and concentrations derived from field experiment in year 2 and 3. They also will be provided a Petri dish containing pollen dough, prepared by mixing ground floral pollen with sucrose solution (50%) at a ratio of 1:0.4 (pollen: sucrose solution). To calculate food consumption, the pollen dough will be changed every other day and weighed at the beginning and the end of each time interval. Feeders will be replaced three times a week and weighed at the beginning and the end of each time interval. The bumble bees will be allowed to feed *ad libitum* for 80 days.

Survival of adult worker bees will be checked daily and dead individuals will be removed and stored at –20C. Survivorship will be analyzed using Cox proportional hazard model. The whole experiment will be terminated after 80 days and all surviving bees stored at –20C. Male offspring and the three workers per colony will be dried at 80C for 4 h and weighed on a microbalance (Mettler Toledo MX5, d = 1 g; ± 2g) (Mettler-Toledo GmbH, Greifensee, Switzerland). In summary, from the microcolonies, we will obtain measures of bumble bee survivorship after the different imidacloprid treatments, mean weight of surviving bumble bees, number of offspring produced, and consumption of sucrose and pollen. The experiment will be repeated three times, using new hives for each replicate.

<u>Effects of imidacloprid on honey bee health.</u> We will start this study in year 2 and 3, after we have worked out the methods with bumble bees. Based on the residue levels in field, we will treat 36 colonies as follows: one set of 12 colonies will receive a low concentration of imidacloprid (1X, 40 ppb); another 12 colonies will receive a high concentration of imidacloprid (10x, 400 ppb), and the last 12 colonies will be untreated to serve as controls. In the first summer, the imidacloprid will be added to sugar syrup (50% wt/vol) and fed to the colonies. In the second summer, imidacloprid will be added to pollen patties (supplementary protein feed: Mann Lake Beekeeping Supply). The colonies will begin as packages or 3lbs of bees and a queen, and hived in new beekeeping equipment. They will be treated with the antibiotic Fumagillan to treat for *Nosema* sp (a microsporidian), and with ApiGuard to treat for *Varroa destructor* mites. In this way, we will minimize the primary confounding pathogens that negatively affect colony health so we can focus primarily on the effects of the insecticide.

<u>Measures of colony health:</u> Forty days after the new colonies are initiated, when the adult bees in the colonies have at least doubled in population and brood of all stages (eggs, larvae and pupae) is present, we will begin the sugar syrup or pollen treatments. We will place dead bee traps in front of all colonies to quantify daily mortality of adult bees (dead bees will be counted in the traps every 3 days). We will quantify egg laying rates of queens 3 days and 2 weeks after treatment by confining the queen to one comb within a screened cage for 24 hours and measuring the number of wax cells containing an egg. We will quantify brood viability by counting the number of 5^{th} (last) instar larvae, and 10 days later the number of pre-emergence pupae within 3 replicated 100 cell areas. By recording viability of larvae and pupae we can begin to determine if the imidacloprid affects either or both stages of development. We will measure short-term weight gain, an assay highly correlated with honey production. Finally, we will record queen supersedure attempts (rejection by the workers), and any clinical symptoms of disease or parasites.

<u>Behavioral effects on learning:</u> We will use the odor conditioning PER assay, used with bumble bees, to study the effects of imidacloprid on learning in honey bees. We will age-mark newly

emerged bees by painting a spot of Testor's enamel paint on the thorax and collect them when they are 7-12 days old (pre-foraging age), and another set when they are 20-25 days old (foraging age). We will collect bees from 3 colonies at each treatment level and the control colonies (20 bees at each age from each of 12 colonies). We will conduct PER learning trials, as described in above, to compare any sub-lethal effects of the imidacloprid treatments on the learning and memory of adult bees.

Research result 2. We will study established plantings at the MN Landscape Arboretum (Chaska, MN) and St. Paul Campus to determine the best plants for seasonal phenology of food for pollinators in MN. Twenty-four stations (divided into 3 plots) will be chosen based on proximity to specific plant species in order to obtain replicated samples. These stations will be used for data collection on behavioral observations of beneficial insects visiting flowers and sticky trap collection. Teams of 2 will observe flowers at each of the 24 flagged station, 8 times each month. Observations will last for ten-2 minute intervals between 1000 and 1500 h and the number of insects visiting the flowers and taxa of insect will be recorded. Standard yellow sticky traps (Gempler's No bait, length x width: 20.3 x 30.5 cm) will be placed at the flagged stations for a 48 h period 4 times a month. We will visit another restoration and perform behavioral observation, such as Kelly Farm (Elk River, MN). From our observations, we will add bee plants to the present restoration on Gortner, north of the greenhouses. We have a completed manuscript that will be submitted soon, where we compared visits of beneficial insects to native and bedding plants. We will use the same procedures worked out in that study.

5. Results and Deliverables

Research result 1. The amount of imidacloprid translocated to nectar and pollen of dandelion, rose, and linden will be measured through residue analysis. We will determine amounts of clothianidin in rose pollen since the LD50 are similar for honey bee to imidacloprid. We will determine if imidacloprid causes mortality and alteration in behavior of beneficial insect and bees.

Deliverable 1. We will mitigate pollinator loss by developing landscape pest management protocols using pollinator-friendly insecticides. We alter each landscape pest profile in the online "IPM of Midwest landscapes, 316 pp" by Vera Krischik and John Davidson, to have new entries on pollinator compatible insecticides featuring EPA registered reduced risk insecticides (http://www.entomology.umn.edu/cues/Web/196Sawflies.pdf). We will also develop pollinator friendly insecticide recommendations and place them on the front page of the very popular CUES website (http://www.entomology.umn.edu/cues).

Research result 2. We will determine the best plants to be used in Minnesota landscapes to provide season-long nectar and pollen for pollinators. Most plant recommendations are derived from published lists that were not based on research. When you study these recommended plants in the field, many are not visited by bees or beneficial insects. However, proper bee plants in crop borders, roadsides, and in urban landscapes would supplement the diet of bees and beneficial insects, luring them out of insecticide treated and often less nutritionally rewarding plants.

Deliverable 2. We will mitigate pollinator loss by developing a section of the CUES website on "Mitigating pollinator loss through proper plant selection" as we did for the collaborative plant restoration project with the Washington-Ramsey Watershed District and DNR http://www.entomology.umn.edu/cues/gervais/gv_links.htm). We will develop a bulletin, poster, and plant list.

Deliverable 3. We have selected an Advisory Group (see list above) that includes members from diverse MN landscape related groups: MN DNR, MN DA, MNDOT, MN Honey bee Producers, MN Hobby Bee Keepers, Native Plant Society, Xerces Society, and MNLA (MN Nursery and Landscape Association). We will meet every 4-8 mo to discuss research and outreach projects. We will communicate our research to EPA and discuss needs for warnings on labels. We will deliver 12 workshops around the state of MN on how to conserve pollinators.

6. Timetable

	July 2010 -June 30 2011				July 2011-June 30 2012				2012 July-June 30 2013			
	Su	**Fall**	**Win**	**Sp**	**Su**	**Fall**	**Win**	**Sp**	**Su**	**Fall**	**Win**	**Sp**
Research result 1: Perform residue analysis on insecticide treatments, bioassay with insects												
Establish plants, treat with insecticides	**x**	**GH x**	**GH x**	**GH x**	**x**	**GH x**	**GH x**	**GH x**	x		**GH x**	**GH x**
Collect flowers	x	x			x	x			x	x		
Perform residue analysis		x	x	x		x	x	x		x	x	x
Bioassay with insects	x	x	x	x	x	x	x	x	x	x	x	x
Deliverable 1: Develop reduced risk insecticide protocols for landscape pests, develop research papers, outreach materials												
Research paper				x		x	x	x		x	x	
Bulletin		**x**	**x**	**x**		x	x	x		x		
Update online IPM Manual		**x**	**x**	**x**		x	x	xx		x		
Website		**x**	**x**	**x**		x	x	x		x	x	x
Research result 2: Field observation on best plants for pollinators, develop demonstration plots on St. Paul Campus												
Field observation	**x**	**x**			x	x						
Develop demo plots					x	x			x	x		
Deliverable 2. Develop bee friendly for landscape plants, develop research papers, outreach materials												
Research paper		x	x	x	x	x	x	x	x	x	x	
Bulletin			x	x	x	x	x	x	x	x		
Website		x	x	x		x	x	x		x	x	x
Deliverable 3. Advisory Group Meetings, deliver 12 workshops around the state of MN on how to conserve pollinators												
Committee Meetings	x	x	x	x	x	x	x	x	x	x	x	x
Workshops			x	x		x	x	x		x	x	x

7. Budget

Project Budget: 221-G Mitigating Pollinator Decline
Vera Krischik, UMinnesota
IV. TOTAL PROJECT REQUEST BUDGET

BUDGET ITEM	year1	year2	year3	TOT AMT
Result 1. Research the amount of neonicotinyl insecticides in nectar and pollen and their effects on pollinator health and behavior.				
Deliverable 1. Determine if systemic insecticides commonly used in landscapes are killing pollinators. Develop management plans to reduce the use of systemic insecticides where bees and beneficials are foraging and instead use recently registered EPA low risk insecticides.				
Research 2. Research which native plants provide the best nectar and pollen for bee pollinators.				
Deliverable 2. Develop management plans to use pollinator-friendly plants in conservation plantings, roadsides, rain gardens, and shoreland re-vegetation.				
Research 1 and 2 and Deliverable 1 and 2 will use the same personnel.				
Personnel: Graduate Student $35,000 + 17.14%fringe + yearly increases	$34,304	$34,990	$35,690	$104,984
Personnel: Undergraduate Student	$14,000	$14,000	$14,000	$42,000
Research 1.				
Research supplies: Purchase bumblebees and beneficial insects from insectaries, rearing supplies, cages, insecticides, plants.	$7,940	$7,940	$6,599	$22,479
Research space: Greenhouse space rental and field space rental for bioassays for determining effects of chemical on honeybees and bumblebees.	$8,000	$8,000	$8,000	$24,000
Residue analysis: Measure amount of imidacloprid in pollen and nectar of dandelion, rose, linden with HPLC-mass spec.	$20,000	$20,000	$20,000	$60,000
Research 2.				
Travel: Travel to field sites for behavioral observations to determine best plants for pollinators, such as established conservation plantings (Kelly Farms, Elk River, MN), MN Arboretum, and other restorations. Use sites for data collection on flower visit duration, species of pollinators, pollinator visits, and flower phenology.	$1,000	$1,000	$1,000	$3,000
Research plots: After determining best plants for pollinators, create demonstration site on St. Paul campus. Funds are need for plants, soil amendments, and site preparation. Use sites for data collection on flower duration, pollinator visits, and flower phenology. Use sites for field days and workshops on conserving pollinators and beneficial insects.	$3,000	$3,000	$1,000	$7,000
Subtotal:	$88,244	$88,930	$86,289	$263,463
Deliverable 3. Create advisory panel with stakeholders and meet every 4 mo to discuss research and outreach projects. Develop field days, workshops, and outreach materials. Provide 4 workshops per year, a total of 12 for the grant, to professionals, state agencies, commodity groups, and homeowners on conserving pollinators. Provide articles and talks. Use websites , such as CUES (www.entomology.umn.edu/cues) and UM honeybee (www.extension.umn.edu/honeybees) to disseminate information.				

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Personnel: Undergraduate Student to develop website and outreach materials	$5,000	$5,000	$6,000	$16,000
Outreach publication: Cost for duplicating management recommendations, factsheets, handouts for use at workshops, meetings, and talks.	$4,000	$4,000	$4,000	$12,000
Workshop costs: Registration fees for workshops will cover costs of food, room rental, and advertising.	$0	$0	$0	$0
Workshops and field days: Airfare and hotel for invited speakers from Xerces Society, native plant conservers, and pollinator-friendly organizations.	$1,500	$1,500	$1,500	$4,500
Travel: Mileage to travel to workshops	$500	$269	$268	$1,037
Advisory meetings: No food or room charges	$0	$0	$0	$0
Subtotal:				$33,537
Budget total:				**$297,000**
Acquisition (Including Easements):				NA
Restoration:				NA
Other:				NA
TOTAL PROJECT BUDGET REQUEST TO LCCMR				**$297,000**

V. OTHER FUNDS

SOURCE OF FUNDS				**AMOUNT**
Remaining $ From Previous Trust Fund Appropriation (if applicable):				NA
Other Non-State $ Being Leveraged During Project Period:				NA
Other State $ Being Spent During Project Period:				NA
In-kind Services During Project Period: Krischik inkind 30%/year for 3 yr	**$89,022**			**$89,022**
Past Spending: Research funds 2004-2009,7 published papers on imidacloprid issue, extension bulletin on plants for restorations, UM-DNR poster on plants for restorations, and CUES website				$100,000

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8. Credentials

Project Manager Qualifications and Organization Description

Dr. Vera Krischik, Assoc. Professor Ecology of Urban Landscapes**,** Department of Entomology, University of Minnesota, St. Paul Campus
The PI is a tenured Faculty in the Entomology Department of the College of Food, Agricultural and Natural Resource Sciences at the University of Minnesota. One of the goals of the College is to develop viable food and agricultural systems, while maintaining healthy natural resources. Bees and other pollinators provide ecosystem services in both natural and managed agriculture ecosystems, so it is essentially to protect them. Determining ways to prevent pollinator loss and promote functioning sustainable ecosystems are a goal of my research and outreach programs. The PI has over 30 years of research expertise and publications in this area. Equipment and facilities are available for this research.

Vera obtained her PhD from the University of Maryland in 1984, held at Post Doc at the University of Maryland, was a researcher at the New York Botanical Garden (NSF sponsored Visiting Professor for Women, 1991-1993), and was an IPM coordinator at USDA, Washington DC from 1988-1994. Since 1995, she is a professor in the Department of Entomology at the St. Paul, University of Minnesota. She teaches 2 courses: ENT 5009, Pesticide Use and Misuse and ENT 4015, Ornamental and Turf IPM. She has 6 published papers on the non target effects of imidacloprid on beneficial insects and 2 published papers and 2 in manuscript on the proper use of imidacloprid for landscape plants. She has two books: one published in 1991 by John Wiley entitled "Microbial Mediation of Plant Insect Interactions" and another published in 2004 by the MN Agricultural Experiment Station on "IPM of Midwest Landscapes", 316 pp. She has partnered with MDA, DNR, MNLA, MNTGF, and watershed districts for her outreach and research programs and publications. She has developed a plant restoration bulletin and poster in cooperation with the DNR and Ramsey Watershed District. She teaches at least 5 large workshops each year on proper pesticides use in cooperation with MDA and MNLA. She has trained 6 graduate students and 1 post doc. She is director of CUES: Center for sustainable urban ecosystems that promote natural resource management, online at www.entomology.umn.edu/cues. Dr. Krischik was contacted by MN National Public Radio on June 23, 2009 for an interview on the non-target effects of imidacloprid on birds and bees.

Dr. Vera Krischik's experience with imidacloprid and management of landscape pests online at www.entomology.umn.edu/cues/krischiklab/krischik.htm

1. Tenczar, E. G., and V. A. Krischik. 2007. Comparison of standard (granular and drench) and novel (tablet, stick soak, and root dip) treatments for cottonwood leaf beetle (Coleoptera: Chrysomelidae) management on hybrid poplar. J. Econ. Entomol. 100: 1611-1621.
2. Krischik, V. A., A .Landmark, and G. Heimpel. 2007. Soil-applied is translocated to nectar and kills nectar-feeding Anagyrus pseudococci (Girault) (Hymenoptera: Encyrtidae) Environ. Entomol. 36(5): 1238-1245.
3. Rogers, M. A., V. A. Krischik, and L. A. Martin. 2007. Effect of soil application of on survival of adult green lacewing, Chrysoperla carnea (Neuroptera: Chrysopidae), used for biological control in greenhouse. Biological Control 42(2): 172-177.
4. Gupta, G., and V. A. Krischik. 2007. Professional and consumer insecticides for the management of adult Japanese beetle on hybrid tea rose. J. Econ. Entomol. 100(3): 830-837.
5. Tenczar, E. G., and V. A. Krischik. 2006. Management of cottonwood leaf beetle (Coleoptera: Chrysomelidae) with a novel transplant soak and biorational insecticides to conserve coccinellid

beetles. J. Econ. Entomol. 99(1): 102-108.
6. Smith, S. F. and V. A. Krischik. 2000. Effects of biorational insecticides and imidacloprid on four coccinellid species (Coleoptera: Coccinellidae). J. Econ. Entomol. 93(3): 732-736.
7. Smith, S. F. and V. A. Krischik. 1999. Effects of systemic imidacloprid on *Coleomegilla maculata*. (Coleoptera: Coccinellidae). Environ. Entomol. 28(6): 1180-1195.

Research completed and manuscript finished

1. Tenczar, E. G., and V. A. Krischik. 2010. Effects of irrigation in hybrid polar fields on efficacy of different formulations of imidacloprid.
2. Krischik, V. A.,Gupta, G, and Vasei, A. 2010. Efficacy and duration of imidacloprid in roses.
3. Krischik, V. A.,Gupta, G, Rogers, M, and Vasei, A. 2010. Soil-applied imidacloprid is translocated to nectar and reduces survival of 4 species of cocinellid beetles, but not 2 species of butterflies (submitted, accepted, and in revision)

Books

1.Krischik, V and J. Davidson. 2004. IPM of Midwest landscapes, UMAg Exp Stat., 316pp.
2. Barbosa, P., V. Krischik, and C. Jones.1991. Microbial mediation of plant insect interactions. John Wiley and Sons, 530pp.

Collaborators

Dr. Marla Spivak, Professor and Extension Entomologist Apiculture, Department of Entomology, University of Minnesota

Marla Spivak obtained her PhD from the University of Kansas in 1989, and was a post-doctoral fellow at the Center for Insect Science at the University of Arizona from 1989-1992. Her position at the University of Minnesota began in 1992, and her responsibilities include research, teaching and extension for the 5 state area (MN, WI, IA, SD, ND). Other research projects include understanding the neural mechanisms mediating honey bee hygienic behavior (funded by the NSF since 1993) and studying the social behavior of the bumble bee, *Bombus impatiens*. She teaches courses on Social Insects, Bee Management, and Scientific Communication and Ethics. Other extension projects include publishing a manual on how to rear bumble bees for use in pollination, using solitary bees for apple pollination, and the pollination requirements for cranberries in WI.

Mr. Eric Mader: Xerces Society, National Pollinator Outreach Coordinator, Portland, OR

Eric works to raise awareness of native pollinator conservation techniques among growers and government agencies. His previous work includes commercial beekeeping and crop consulting for the Agrecol Corporation where he provided weekly insect and disease scouting on hundreds of native plant crops. He is a graduate of the University Of Minnesota Department Of Horticulture’s Masters program, and has recently written a book on how to manage non-Apis bee species for the USDA Sustainable Agriculture Network and the Natural Resource, Agriculture, and Engineering Service at Cornell University. He is an adjunct extension educator at the University of Minnesota. He held a Native Pollinator Conservation workshop on June 9, from 9-4, at the University of Minnesota, St. Paul. He has worked with various groups on developing pollinator conservation recommendations.

Advisory Committee

1. Eric Mader, Xerces Society, National Pollination Outreach Coordinator
2. National Honey Bee Advisory Board, Clint Walker, co-chair and Darren Cox, co-chair
3. MN Honey Bee producers, Darel Rufer, President

4. Old Mill Honey Co, Steve Ellis
5. California-Minnesota Honey Farms, Jeff Anderson
6. MN Hobby Beekeepers Association, Dan Malmgren
7. MDA, invasive species group
8. DNR, native shoreland restoration and upland restoration groups
9. MN DOT, such as Todd Carroll, LLA, ASLA, http://dotapp7.dot.state.mn.us/plant/
10. MNLA, MN Landscape Association, Bob Fitch
11. MOTIF, MN Turf and Grounds Foundation, Kathy Are
12. MICAS, MN Golf course Superintendents Association, TAB
13. Sustainability Project Coordinator, City of Minneapolis, June Mathiowetz
14. Native Plants Society
15. MN Nature Conservancy
16. Organic Growers Association

9. Dissemination and Use

This project will address and mitigate pollinator decline with research and outreach programs.
Research result 1. Residue analysis and bioassays will be developed into research papers and a bulletin. Research and bulletin will be posted on the CUES website. The data will be discussed at the 12 workshops delivered around the state.
Deliverable 1. We will mitigate pollinator loss by developing landscape pest management protocols using pollinator-friendly insecticides. We alter each landscape pest profile in the online "IPM of Midwest landscapes, 316 pp" by Vera Krischik and John Davidson, to have new entries on pollinator compatible insecticides featuring EPA registered reduced risk insecticides (http://www.entomology.umn.edu/cues/Web/196Sawflies.pdf). We will also develop pollinator friendly insecticide recommendations and place them on the front page of the very popular CUES website (http://www.entomology.umn.edu/cues). and develop a bulletin.

Research result 2. Data on bee friendly plants will be developed into research papers and a bulletin. Research and bulletin will be posted on the CUES website. The data will be discussed at the 12 workshops delivered around the state. We will work with state agencies and commodity groups to restore habitat with pollinator-friendly plants.
Deliverable 2. We will mitigate pollinator loss by developing a section of the CUES website on "Mitigating pollinator loss through proper plant selection" as we did for the collaborative plant restoration project with the Washington-Ramsey Watershed District and DNR http://www.entomology.umn.edu/cues/gervais/gv_links.htm). We will develop a bulletin, poster, and plant list.

Deliverable 3. We have selected an Advisory Group (see list above) that includes members from diverse MN landscape related groups: MN DNR, MN DA, MNDOT, MN Honey bee Producers, MN Hobby Bee Keepers, Native Plant Society, Xerces Society, MNLA (MN Nursery and Landscape Association), and others (see Advisory Committee list). We will meet every 4-8 mo to discuss research and outreach projects. We will communicate our research to EPA and discuss needs for warnings on labels and other ways to protect beneficial pollinators. We will deliver a workshop on conserving pollinators to 12 locations around MN and disseminate the grant results and products.

Appendix 1: Letters of support

Letters of support:

1. Xerces Society, Portland, OR, Eric Mader, National Pollination Outreach Coordinator
2. National Honey Bee Advisory Board, Clint Walker, Rogers, TX, co-chair and Darren Cox, Logan, UT, co-chair
3. MN Honey Bee producers, Waverly, MN, Darel Rufer, President
4. MN Hobby Beekeepers Association, St. croix, MN, Dan Malmgren
5. California-Minnesota Honey Farms, Eagle Bend, MN, Jeff Anderson
6. Old Mill Honey Co, Barrett, MN, Steve Ellis

THE XERCES SOCIETY
FOR INVERTEBRATE CONSERVATION
4828 Southeast Hawthorne Boulevard Portland, Oregon 97215, USA
Telephone 503-232-6639 Fax 503-233-6794 www.xerces.org

An international, nonprofit organization that protects wildlife through the conservation of invertebrates and their habitat.

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September 15, 2009

To Whom It May Concern,

On behalf of the Xerces Society for Invertebrate Conservation I would like to express my strong support for Dr. Krischik's LCCMR proposal titled "Mitigating Pollinator Decline in Minnesota."

While the non-native European honey bee (*Apis mellifera*) has been the focus of highly publicized reports following its dramatic nationwide decline over the past several years, our native bees, including Minnesota's approximately 500 endemic bee species are suffering equally alarming losses. In many cases these bees are significantly more effective pollinators on a bee-for-bee basis than the non-native honey bee, especially for native food crops such as blueberry, cranberry, and squash, and for the native wildflowers which form the foundation of healthy natural ecosystems.

In fact nearly 70% of all native plants require insect pollination for reproduction, and according to our best available data, the fruits and seeds produced through insect pollination comprise nearly 25% of the direct food supply for terrestrial birds and mammal—including species as diverse as songbirds and black bears.

As an example of the pollinator declines taking place in Minnesota, three of the state's 12 endemic, and formerly common bumble bee species, the yellow banded bumble bee (*Bombus terricola*), the rusty patched bumble bee (*B. affinis*), and the cuckoo bumble bee (*B. ashtoni*), have not been observed in almost a decade. Their likely extirpation represents a loss of approximately one-fourth of the state's bumble bee biodiversity, and an alarming threat to the profoundly important ecological service of pollination.

The threats facing pollinators are many. However two widely recognized reasons for the loss of pollinator diversity and abundance are the loss of habitat, and the use of pesticides. Dr. Krischik's proposal directly addresses those threats and proposes well reasoned and much needed solutions for mitigating further losses. This proposal is grounded in the best available science and engages precisely the constituent audiences most capable of affecting positive change. I urge to fully support this important work.

Sincerely,

Eric Mader
National Pollinator Outreach Coordinator

National Honey Bee Advisory Board

AMERICAN BEEKEEPING FEDERATION AMERICAN HONEY PRODUCERS

AHPA

September 21, 2009

Dear LCCMR committee members,

The National Honey Bee Advisory Board represents the vast majority of the beekeeping industry of the United States on issues relating to pesticides. We work directly with EPA, USDA, and university researchers around the country in an effort to improve pollinator protection.

Systemic pesticides such as imidacloprid are a major concern to our group. Unlike conventional pesticides, which are applied topically, these new compounds actually are taken up by the plant tissue and moved through out the plant including the pollen and nectar. Chemical levels of great concern have been found in floral nectar and pollen, but more research is desperately needed to quantify the hazard to pollinators.

Dr. Vera Krishik is a leading researcher in this field. She is well-qualified to conduct this proposed project to mitigate pollinator decline in Minnesota. In fact, we believe that the research she is requesting you to fund will play a profoundly important role in addressing what has become a national as well as worldwide problem.

The great value of pollinators to a healthy planet is often not fully appreciated. A recent BBC Radio 4 broadcast, *Earthwatch* described bees as "Irreplaceable – the world's most invaluable species," noting these facts:

* 250,000 species of flowering plants depend on bees for pollination
* Bees pollinate ¾ of the 80 major world crops
* Their economic value was estimated in 2005 at £130 billion for pollination services
* 25% terrestrial species would go extinct without them

You have a unique opportunity to help solve a major issue of worldwide importance by approving this important grant proposal. The beekeepers of Minnesota and the nation need your assistance; please help us.

Sincerely,

Clint Walker III, Co-Chair Darren Cox, Co-Chair

Sep 27 09 08:26p RUFER'S APIARIES 17636584036 p.1

1907-2007 100 YEARS

MINNESOTA HONEY POLLINATION

MINNESOTA HONEY PRODUCERS ASS'N., INC.

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President
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Waverly MN 55390
763-658-4035

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Vice President
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EDITOR:
MARK & TANYA SUNDBERG
120 W. Vernon. Ave.
Fergus Falls MN 56537
218-736-2606

September 25, 2009

To Whom It May Concern:
(Which is all of us!)

The MN Honey Producer Association (MHPA) is in strong support of your research efforts to determine what is killing bees and pollinators in general. Honey bees and the pollination services that they provide are under threat from a combination of factors called Colony Collapse Disorder (CCD). One contributing factor to bee decline may be the presence of insecticides in flower nectar in the foraging environment. We need immediate research to help determine some of the causes of bee decline and reduction in pollination.

We have provided annual financial contributions for research at the University of Minnesota on honey bees for over 25 years. We feel this particular issue of insecticides is one of the most important ones we have right now. We will cooperate with the University of Minnesota by providing access to our members so they can conduct surveys and collect information on CCD! We would like the state to provide research funds so data can be collected to determine if systemic insecticides are accumulating in nectar and pollen and contributing to the loss of our honey bee colonies.

It not only effects honey bees, but all other native pollinators and more plants of a wider time frame of pollen and nectar production whether native planting and none native planting, it is extremely important! This research could be a lifeline to our pollinators that are our "angels of agriculture".

Sincerely,

Darrel J. Rufer, President
Minnesota Honey Producers, Assoc.

RESEARCH EDUCATION PROMOTION

Minnesota Hobby Beekeepers Association
14787 Morgan Av N
Marine on the St. Croix, MN 55047

"Better Beekeeping Through Education"

September 30, 2009

Legislative-Citizen Commission on Minnesota Resources
Room 65, State Office Building
100 Rev. Dr. Martin Luther King Jr. Blvd.
St. Paul, Minnesota 55155

Dear LCCMR,

The Minnesota Hobby Beekeepers Association strongly supports and encourages you to support the proposed research by Drs Krischik and Spivak on determining the effects of neonicotinyl insecticides on bees and on providing more floral resources to support our pollinators. Systemic insecticides accumulate in nectar and pollen, and bees are very susceptible to the neonicotinyl class of insecticides. This is a very important emerging issue for natural resources and agriculture in MN since bees pollinate 75% of most native plants including most of the domestic crops and home gardens. This research is a very important step in understanding why honey bees are experiencing Colony Collapse Disorder, and why our native bee pollinators are in decline. If these insecticides are contributing to the demise of bees, we need to be very proactive about protecting bees from these compounds. The best way to be proactive is to promote plantings of bee pollinated flowers in our urban and agricultural landscapes.

The University of Minnesota Entomology Department has been world-renowned reputation for its research, education and contributions to insect science and in particular, to beekeeping and bee health. Drs. Marla Spivak and Vera Krischik, and Scientist Gary Reuter (Spivak's technician) share their research giving presentations to state, national and world entomology and beekeeping organizations. They have very effective Extension and Outreach programs to help get research findings out to beekeepers and the public.

The Minnesota Hobby Beekeepers Association is proud to be an affiliate of the University of Minnesota. We are comprised of beekeepers as a hobby and small business. We have over 300 members in Minnesota and Wisconsin. Our mission is better beekeeping through education. We have been privileged to have Doctor Spivak and Scientist Gary Reuter as our advisors, and look forward gleaning more knowledge form Dr. Krischik also in the future.

If you have any questions, please feel free to contact me.

Thank you for your consideration,

Dan Malmgren
Dan Malmgren, President
(651)-503-9239

California Honey
Pollination & Honey
Minnesota Farms

Jeff & Christine Anderson
721 Wells Street
Eagle Bend, MN 56446
(218) 738-6712

September 23, 2009
Dear LCCMR committee members:
Please fund…*"Mitigating Pollinator Decline in Minnesota G. Creative Ideas"*

You should be aware that pollinators are in decline in Minnesota. Pollinators are critical for a healthy environment, pollinating plants and keeping them viable for wildlife's food and shelter. *Without healthy pollinators much of what LCCMR is trying to accomplish for Minnesota environment won't be successful.*

12/31/08 BBC Radio 4 broadcast, Earthwatch described bees as "Irreplaceable – the world's most invaluable species" noting these facts…

- *250,000 species of flowering plants depend on bees for pollination*
- They pollinate ¾ of the 80 major world crops
- Their economic value was estimated in 2005 at £130 billion for pollination services
- *25% terrestrial species would go extinct without them*

Insecticides kill insects, many pollinators are insects.

Managed honeybee colonies are an excellent gauge of the health of native pollinators. *EPA uses managed honeybees as the barometer for all insect pollinators.* As a commercial beekeeper I can attest to the fact that *use of insecticides on blooming plants kills honeybees*. One can extrapolate similar losses to native pollinators.

The method of applying insecticides is changing. Until relatively recently pesticide applications were generally topical. Today many are applied as soil drenches and seed treatments designed to treat the plant systemically. Many of the systemics' are nicotine based. Nicotinics', as they are referred to, work systemically in plants making them, their pollen, and nectar toxic. There is a very fine line between the dose which kills pests and one that kills beneficial insects. A number of countries are taking a hard look at systemic nicotinic's. Here are several articlesof interest…excerpts from

Germany 2008;
http://www.greatsunflower.org/en/forum/general-discussion/real-cause-ccd-imidacloprid-its-family

"(NaturalNews) German government researchers have concluded that a bestselling Bayer pesticide is responsible for the recent massive die-off of honeybees across the country's Baden-Württemberg region."…

"Researchers found buildup of the pesticide clothianidin in the tissues of 99 percent of dead bees"…

"nearly 97 percent of honeybee deaths had been caused directly by contact with the insecticide"…

"the government has banned an entire family of pesticides, fueling accusations that pesticides may be responsible for the current worldwide epidemic of honeybee die-offs."
England 2009
http://www.buglife.org.uk/Resources/Buglife/Neonicotinoid%20insecticides%20report.pdf

"…*unexplained collapse in Britain's bee population is being exacerbated by a group of widely used systemic pesticides called neonicotinoids* already banned in much of the European Union"…

October 1, 2009
Page 2

"…This is the most comprehensive review of the scientific evidence yet and it has *revealed the disturbing amount damage these poisons can cause to bees*…"

US 2009
http://pollinatethis.org/beeblog/2009/05/24/us-honeybee-advisory-board-asks-epa-to-ban-imidacloprid/

…"American beekeepers, who claim the product is a cause of colony collapse disorder, which has cost many commercial U.S. beekeepers at least a third of their bees since 2006, and threatens the reliability of the world's food supply"…

…"Bayer scientists found imidacloprid in the nectar and pollen of flowering trees and shrubs at concentrations high enough to kill a honeybee in minutes. The disclosure recently set in motion product reviews by the California Department of Pesticide Regulation and the EPA"…

…"2007 studies, Bayer applied standard doses of imidacloprid to test trees, including apple, lime and dogwood. Its scientists found imidacloprid in nectar at concentrations of up to 4,000 parts per billion… (Honeybees can withstand a dose of up to 185 ppb…)"

"National Honeybee Advisory Board, which represents the two biggest beekeeper associations in the U.S., recently asked the U.S. Environmental Protection Agency to ban the product. "We believe imidacloprid kills bees"

EPA currently only looks at the acute toxicity of pesticides. They do not consider that bio accumulating systemic insecticides are doing damage to pollinators when used according label directions. EPA can only take action when they have scientific facts in front of them. Obviously chemical manufacturers only supply EPA with required information, so even if 'they' know of problems, 'they' are not 'required' to submit that information. This is why private research is crucial. EPA will not act unless and until scientific evidence is supplied showing a need for change.

Professor Vera Krischik/University of Minnesota, has submitted a research proposal; *"Mitigating Pollinator Decline in Minnesota G. Creative Ideas"*
I strongly recommend funding of this research proposal. It is imperative to learn if nicotinic's are 'safe enough' for use in our Minnesota environment.

I anticipate hearing that this vital research is to be funded. Thanks for your consideration.

Sincerely
Jeff Anderson
California-Minnesota Honey Farms
721 Wells Street
Eagle Bend, MN 56446
(218) 738-6712

OLD MILL HONEY CO.
20501 Co Rd 5
Barrett, MN 56311
September 15, 2009

To: MN LCCMR Committee:

My name is Steve Ellis. I have been a commercial beekeeper for 28 years. My business, Old Mill Honey, operates 2,300 hives of bees in California and Minnesota. Commercial beekeepers like myself pollinate crops from almonds to apples to cherries as well as hundreds of other blooming crops. Unfortunately, the honeybee industry and, in fact all pollinators, are suffering an unprecedented and catastrophic decline.

For the last four years a previously unknown ailment has been decimating the U.S. beekeeping industry. This affliction kills off entire colonies of bees in a matter of only a few days; 60-80% of entire operations can disappear within a few short weeks. This phenomenon is so new in fact that a name had to be invented for it: CCD or Colony Collapse Disorder. Much media attention has been given to the subject. From people on the street to flight attendants on commercial airlines, people see my beekeeping cap and ask, "What's happening to the bees?"

This heightened public awareness has carried with it the "silver lining" of underscoring the vital importance of honeybees in our food production systems. Without honeybees and their pollination of food crops, we will loose fully one-third of our diet. Simply put, we will all be eating gruel, because cereal grains are one of the few foods that can be produced without insect pollination.

Put this way most people then ask me, "What do you think is causing this problem and what can I do to help?" I have been active in the beekeeping industry, attending regularly our state and national beekeeping association meetings, and I try hard to stay as informed on industry concerns as I can. My strong belief is that this dramatic decline of pollinators which we have experienced is directly related to the recent heavy use of neonicotinoid systemic insecticide.

Unfortunately the way things work in the United States today most research done on newly registered pesticide compounds is commissioned and paid for by the chemical industry. The beekeeping industry does not have sufficient funds to commission independent researchers to determine safety for pollinators. A project funded by the LCCMR would have a critically important feature: *independence.*

Here in Minnesota we are very fortunate to have at the University of Minnesota researchers with experience testing both honeybees and this new chemical class of neonicotinoids. Professors Vera Krischik and Marla Spivak would bring the

2

necessary expertise to be able to make a significant contribution to this critically timely issue. I personally know both of these researchers and I can tell you that the state's money will be very well invested in their competent hands.

This proposal will definitely help solve the mystery of what is killing off our essential pollinators. Minnesota is in a unique position to assist in this essential work. Dr. Krischik is one of the leading research scientists, and her emphasis in Neonicitinoid systemic insecticides places her in a position to really make a difference. As a beekeeper, I can tell you this grant is desperately needed.

Sincerely,

Steve Ellis

Appendix 2. Literature Citations

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