Environment and Natural Resources Trust Fund (ENRTF)
M.L. 2014 Work Plan

Date of Report: February 10, 2014
Date of Next Status Update Report: January 30, 2015
Date of Work Plan Approval:
Project Completion Date: June 30, 2017
Does this submission include an amendment request? no

PROJECT TITLE: **Understanding Systemic Insecticides as Protection Strategy for Bees**

Project Manager: Vera Krischik
Affiliation: University of Minnesota
Mailing Address: 1980 Folwell Ave # 219
City / State / Zip: St. Paul, MN 55108
Telephone Number: 612-625-7044
Email Address: krisc001@umn.edu
Web Site Address: www.entomology.umn.edu/cues

Location: statewide

Total ENRTF Project Budget:		
	ENRTF Appropriation:	**$326,000**
	Amount Spent:	**$0**
	Balance:	**$326,000**

Legal Citation: M.L. 2014, Chp. 226, Sec. 2, Subd. 06b

Appropriation Language:
$326,000 the second year is from the trust fund to the Board of Regents of the University of Minnesota to continue research on how native bee and honey bee colonies are impacted by systemic, neonicotinyl insecticides in pollen and nectar of plants growing in fields and landscapes. This appropriation is available until June 30, 2017, by which time the project must be completed and final products delivered.

I. PROJECT TITLE: **Understanding Systemic Insecticides as Protection Strategy for Bees**

II. PROJECT STATEMENT:

Honey bees and bumblebees pollinate 1,000's of native plants and crops that produce the seeds, fruits, and nuts that we consume and bees contribute approximately $15 billion worth of crop yields. Since 2007 managed honey bee colony mortality was estimated as 30% and also, native North American bumblebee species are in decline. Bee loss is due to a combination of factors, such as insecticides, habitat loss, and disease. Neonicotinyl insecticides are systemic, which means they are applied to the soil or on seeds and move from the soil to roots, leaves, pollen, and nectar. In the U.S., one-third of all crop (143 million acres / total 442 million acres) are treated with over 2 million pounds of neonicotinyl insecticides. In 2009 in Minnesota, corn, soybeans, potatoes and canola used 46,766 pounds and landscapes used 6,000 pounds of imidacloprid and 19,347 pounds of clothianidin, two of the chemicals that are classified as neonicotinyl insecticides. The high use of neonicotinyl insecticides makes it probable that a foraging bee will eat nectar and pollen from a neonicotinyl-treated plant, which can reduce foraging, reduce colony health, and kill the bees. Bee loss will contribute to reduced pollination, seeds, and fruits of native plants and crops.

One of the major deficits in knowledge is how much neonicotinyl insecticide is found in pollen and nectar of neonicotinyl–treated plants, besides seed-treated crops. A canola seed is covered with 0.11 mg active imidacloprid (neonicotinyl chemical) that results in 7.6 ppb imidacloprid pollen. In urban landscapes, where bees forage for pollen and nectar, a soil surface application of imidacloprid can be applied to a native plant (300 mg) and basswood tree (67 g) from which basswood honey is produced. We calculate that a 609,000 times greater amount of imidacloprid is applied to basswood trees compared to a canola seed. We do not know how much imidacloprid accumulates in pollen and nectar from these applications in the landscape and field. The proposed research is performed in the field, which represents actual conditions.

The purpose of this research is:

1. Determine imidacloprid residue in pollen and nectar of basswood trees from an imidacloprid soil drench and trunk injection.
2. Determine the imidacloprid residue in native plants around imidacloprid-treated trees.
3. Determine imidacloprid residue in pollen and nectar of native flowers, squash, and blueberry from imidacloprid soil drenches.
4. Determine the impacts of these imidacloprid residues on colony health of native bumblebee colonies.

This research is different from our 2010 LCCMR grant as all studies are done in the field and the previous study was done in the greenhouse. For the research and outreach products from the 2010 LCCMR grant visit "Pollinator conservation" (www.entomology.umn.edu/cues/pollinators/index.html).
We have letters of support from the Department of Agriculture in the State of Washington, Colorado State Beekeepers, Boulder County Beekeepers, Minnesota Honey Producers Association, and two Minnesota commercial beekeepers.

III. PROJECT STATUS UPDATES:

Project status as of January 30 2015
Project status as of June 30 2015
Project status as of January 30 2016
Project status as of June 30 2016
Project status as of January 30 2017
Project status as of June 30 2017
Final report summary: August 2017

Overall Project Outcomes and Results:
The outcome and results of this project are to understand how much residue of imidacloprid is found in pollen and nectar of flowering plants from a soil drench and trunk injection of imidacloprid and investigate the effects on bumblebee colony health in the field.

1V. PROJECT ACTIVITIES AND OUTCOMES

ACTIVITY 1: Determine imidacloprid residue in pollen and nectar of flowers
Description: We will determine the amount of imidacloprid in nectar and pollen of flowering plants after a soil drench and trunk injection of imidacloprid. The USDA AMS Lab in Gastonia, NC will perform he residue analysis as its results will be accepted by the EPA and other regulatory agencies interested in the effects of imidacloprid on bees and beneficial insects.

Summary Budget Information for Activity 1: **ENRTF Budget $276,300**
Amount Spent: $0
Balance: $276,300

Activity Completion Date: June 30 2017

Outcome 1. Determine imidacloprid in flowers.	**Completion Date**	**Budget**
1-1. Determine imidacloprid residue in pollen and nectar of basswood trees from a soil drench and trunk injection.	2017	$120,000
1-2. Determine the imidacloprid residue in native plants around imidacloprid-treated trees.	2017	$80,000
1-3. Determine imidacloprid residue in pollen and nectar of native flowers, squash, and blueberry from imidacloprid soil drenches.	2017	$76,300
1-4. Share the research results with collaborators through talks, additions to the pollinator website, and emails.	2017	$0

Project status as of January 30 2015
Project status as of June 30 2015
Project status as of January 30 2016
Project status as of June 30 2016
Project status as of January 30 2017
Project status as of June 30 2017
Final report summary: August 2017

ACTIVITY 2:
2-1. Determine the impacts of these imidacloprid residues on colony health of native bumblebee colonies.
Description: We will determine if bumblebees colonies established in the field near flowering plants that were treated with imidacloprid have reduced colony health.

Summary Budget Information for Activity 1: **ENRTF Budget: $49,700**
Amount Spent: $0
Balance: $49,700

Activity Completion Date: June 30, 2017

Outcome 2 Determine affects on bees.	**Completion Date**	**Budget**
2-1. Determine the impacts of these imidacloprid residues on colony health of native bumblebee colonies.	2017	$49,700
2-2. Share the research results with collaborators through talks, additions to the pollinator website, and emails.	2017	$0

Project status as of January 30 2015
Project status as of June 30 2015
Project status as of January 30 2016

Project status as of June 30 2016
Project status as of January 30 2017
Project status as of June 30 2017
Final report summary: August 2017

V. DISSEMINATION:

Description:

The research will be posted on the CUES website (www.entomology.umn.edu/cues) and updated every 6 months. Every 6 months we will email our progress to our interested parties listed under section VII. From the research, we will develop peer reviewed publications, outreach bulletins, and outreach talks.

Project status as of January 30 2015
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Project status as of January 30 2016
Project status as of June 30 2016
Project status as of January 30 2017
Project status as of June 30 2017
Final report summary: August 2017

VI. PROJECT BUDGET SUMMARY:

A. ENRTF Budget Overview:

Budget Category	$ Amount	Explanation
Personnel:	$220,700	Grad student , technicians
Professional/Technical/Service Contracts Tree care company to apply imidacloprid to soil and to inject basswood trees	$7,000	Licensed MDA arborists for trunk injections
Residue analysis of imidacloprid performed at USDA AMS Lab in Gastonia, NC, EPA approved lab, cost $166/sample, 20 trees x 2 samples x 2 months x 2 yrs= 160 samples x $166 = $26,560; and 4 flowering plant species x 12 individuals x 2 samples x 2 yrs = 192 samples x$166 = $31,872; total 352 samples x $166 = $58,432 + $1568 shipping samples overnight express on dry ice :	$60,000	Residue analysis must be done at the EPA approved USDA AMS, Gastonia, NC lab to be valid
Equipment/Tools/Supplies: Research supplies: Bumblebee colonies, greenhouse space, insecticides, research landscapes to be planted	$30,300	Equipment to ready bumblebee colonies to be established and monitored in the field; insecticides and plants to set up trial gardens for determining imidacloprid residue in flowers and the effects of imidacloprid on bumblebee colony health
Printing: Reports and fact sheets for distribution at meetings	$2,000$	Cost for duplicating management recommendations, factsheets, handouts for use at meetings and talks.
Travel Expenses in MN: Instate travel to research sites	$6,000	Instate travel to research
TOTAL ENRTF BUDGET:	**$326,000**	

Explanation of Use of Classified Staff: none
Explanation of Capital Expenditures Greater Than $5,000: none
Number of Full-time Equivalents (FTE) Directly Funded with this ENRTF Appropriation: 1.5 FTE for a graduate student, 1.5 FTE for a Post Doc, and 0.68 FTE for a technician, = total of 3.68 FTE.
Number of Full-time Equivalents (FTE) Estimated to Be Funded through Contracts with this ENRTF Appropriation: Tree Arborist Service for trunk injections and soil drenches of basswood trees, 0.05 FTE (5 weeks each year for 2 years). USDA AMS NC residue lab to quantify imidacloprid, 0.5 FTE, = total 0.55 FTE

B. Other Funds:

Source of Funds	$ Amount Proposed	$ Amount Spent	Use of Other Funds
Non-state	none		
State			
In-kind Services: 1% PI cost share	$3,205	$0	
TOTAL OTHER FUNDS:	**$3,205**	**$0**	

VII. PROJECT STRATEGY:
A. Project Partners:
The research will be performed in the lab of Dr. Vera Krischik (Landscape Plant Pest Management), Department of Entomology at the University of Minnesota, St. Paul Campus. Interested parties will be sent email reports every 6 mo. We have letters of support from some of our project interested parties: 1. Minnesota Honey Producers (President Dan Whitney), 2. and 3. MN Beekeepers (Steve Ellis and Jeff Anderson), 4.Colorado State Beekeepers (President Beth Conrey), 5.Boulder County Beekeepers (President Miles McGaughey), and 6. And 7. Washington Department of Agriculture (Director Bud Hoover and Chief Erik Johansen). Other interested parties are:
8. Sarah Rudolf, Minnesota Pollution Control Agency,
9. and 10. Crystal Boyd and Dana Robert, Minnesota Department of Natural Resources,
11. Lois Eberhart, City of Minneapolis Surface Water & Sewers Administrator, Department of Public Works,
12. Gail Nozal, certified arborist, S & S Tree Service,
13. Ralph Siefert, MPRB, Minneapolis Park and Recreation Board,
14. Les Potts, Supervisor, Landcare, UMinnesota,
15. and 16. Eric Mader and Mathew Shepard, Xerces Society and adjunct extension educator, UMinnesota
17. Larissa Walker, Center for Food Safety, Washington DC
18. Lex Horan, Pesticide Action Network NA, PANNA, Minneapolis, MN
19. Erik Runquist, MN Zoo

B. Project Impact and Long-term Strategy:
The purpose of this research is to determine if systemic, neonicotinyl insecticides are translocated to pollen and nectar in flowers and what impact these insecticides have on bee foraging and colony health. Neonicotinyl insecticides are neurotoxins that affect vision, olfaction, learning, and memory and bind to mushroom bodies in bee brains which are particularly large in social bees compared to other insects. Bees fed 13 ppb or 23 ppb imidacloprid were less likely to form long-term memory and had reduced learning and at 24 ppb imidacloprid performed fewer communicative waggle dances.

The ubiquitous use of neonicotinyl insecticides on crops and landscape plants throughout the season may lead to chronic sublethal and lethal effects on worker foraging and colony health. Social bee colonies, such as bumblebees and honey bees, rely on division of labor and need foragers to return nectar to the hive for the queen and brood. Native, annual bee colonies or bumblebee queens in spring and fall are even more vulnerable to neonicotinyl insecticides since the solitary queens can be impaired when foraging. Since most studies show reduction in foraging behavior below 10 ppb and residues in crop and landscape flowers are probably higher

than 10 ppb, bees are likely to be experiencing chronic, sublethal doses with consequences on queen and colony health.

The research will be posted on our outreach center the CUES website (www.entomology.umn.edu/cues) and updated every 6 mo. This information will be discussed with consumers, master gardeners, commodity groups, state agencies in Washington, Colorado, and Minnesota, and the US EPA. So far, these research data have been requested by groups that need to understand more about the risk of neonicotinyl insecticides to bees: US EPA, Center for Food Safety, Pesticide Action Network (PANNA), and Xerces Society for Invertebrate Conservation, Washington State Department of Agriculture, Pesticide Research Institute, MN Honey Producers, Boulder County Bee Keepers, and Colorado State Beekeepers.

. Spending History:

Funding Source	**M.L. 2008 or FY09**	**M.L. 2009 or FY10**	**M.L. 2010 or FY11**	**M.L. 2011 or FY12-13**	**M.L. 2013 or FY14**
USDA SARE grant		$175,000	In progress	Finished	
LCCMR 2010 221G, Mitigating bee decline		$297,000	In progress	Finished	
UMN MAES project		$4,000	$4,000	$4,000	

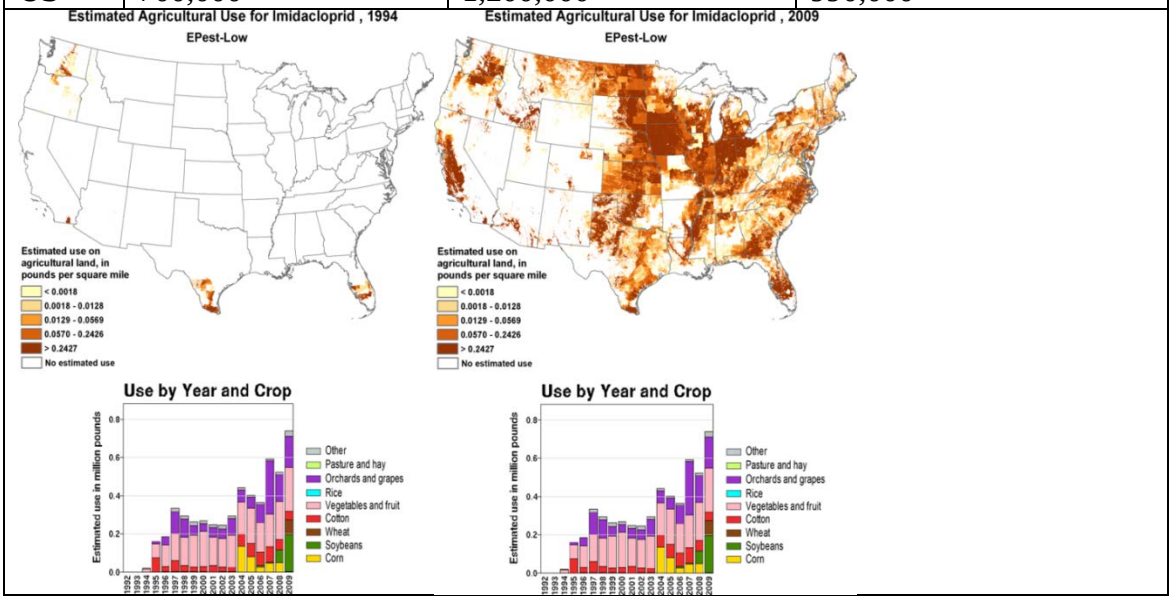
VIII. ACQUISITION/RESTORATION LIST: none

IX. VISUAL ELEMENT or MAP(S):

2014 LCCMR proposal
Project title: Understanding Systemic Insecticides as Protection Strategy for Bees
Project PI: Vera Krischik, Department of Entomology, U of Minnesota

In 2009 143/442 million acres in the US use a neonicotinyl insecticide, 83 million acres of corn have seed treatments of neonicotinyls, and honeybees rely on corn for pollen

	Imidacloprid lbs (ai)	Clothianidin lbs (ai)	Thiamethoxam lbs (ai)
MN	52,048	43,663	68,876
CA	348,247	3,182	30,687
US	700,000	1,200,000	990,000



The purpose of this research is:
1. Determine imidacloprid residue in pollen and nectar of basswood trees from an imidacloprid soil drench and trunk injection.
2. Determine the imidacloprid residue in native plants around imidacloprid-treated trees.
3. Determine imidacloprid residue in pollen and nectar of native flowers, squash, and blueberry from imidacloprid soil drenches.
4. Determine the impacts of these imidacloprid residues on colony health of native bumblebee colonies.

Bees feed on pollen and nectar which results in pollination and the production of fruits and seeds. Both native bumblebees and managed honey bees have been in decline since neonicotinyl insecticides were registered in 1990. Loss of habitat, new pathogens, and lack of native plants for food also contribute to reduced bee health. Recent papers show that pesticide exposure to bees makes them more vulnerable to pathogens.

The majority of insecticides are called contact insecticides as the insect, by walking on the leaf or eating the leaf, absorbs the insecticide from the surface of the plant for 1-3 weeks. A flower that opens after a contact insecticide is sprayed has no insecticide in the pollen and nectar. Systemic insecticides move from the soil to the leaves and pollen and nectar of the plant and can remain in the plant for a year. Every flower that opens has neonicotinyl insecticides in it. Every time an insect feeds on the pollen and nectar the bee consumes the systemic insecticide.

Systemic neonicotinyl insecticides (imidacloprid, clothianidin, dinotefuran, and thiamethoxam) are widely used due to low toxicity to humans, but they are very toxic to bees and birds as addressed in two new review papers by the Xerces Society (2012) and American Bird Conservatory (2013). To understand how little kills a bee, let us think of a heart healthy aspirin that is 80 milligrams = 80,000 micrograms= 80,000,000 nanograms (ng). A bee that eats 4-40 ng imidacloprid can be killed and 1- 3 ng reduces the bee's ability to forage, navigate, and return to the hive. Research showed that bee brains have 40x more nicotinic receptors compared to other insects, as bees perform higher brain functions dealing with memory, spatial orientation, and learning.

Soil drench or trunk injection of trees is very commonly practiced, but little data on neonicotinyl residue in tree flowers is published. On June 18 2013, 25,000 bumblebees were killed at a Target store in Wilsonville, Oregon when the bees fed on nectar from linden trees treated with the neonicotinyl insecticide dinotefuran (label Safari). The incident was documented by the Oregon Department of Agriculture which covered the treated trees with netting and a 6 mo. ban on dinotefuran was initiated.

X. ACQUISITION/RESTORATION REQUIREMENTS WORKSHEET: none

XI. RESEARCH ADDENDUM: A research addendum was submitted to the LCCMR staff on January 15, 2014.

XII. REPORTING REQUIREMENTS:
Periodic work plan status update reports will be submitted no later than January and June 2015, January and June 2016, and January and June 2017. A final report and associated products will be submitted between June 30 and August 15, 2017.

Environment and Natural Resources Trust Fund

M.L. 2014 Project Budget

Project Title: Understanding Systemic Insecticides as Protection Strategy for Bees

Legal Citation: M.L. 2014, Chp. 226, Sec. 2, Subd. 06b

Project Manager: *Vera Krischik*

Organization: *University of Minnesota*

M.L. 2014 ENRTF Appropriation: $ *326,000*

Project Length and Completion Date:3 *Years, June 30, 2014-June 30, 2017*

Date of Report: *February 10 2014*

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET	Activity 1 Budget	Amount Spent	Activity 1 Balance	Activity 2 Budget	Amount Spent	Activity 2 Balance	TOTAL BUDGET	TOTAL BALANCE
BUDGET ITEM	***Determine imidacloprid in flowers***			***Determine affects on bumblebees***				
Personnel (Wages and Benefits):	$188,000	$0	$188,000	$32,700		$32,700	$220,700	$220,700
Graduate Student, $117,800 (55%salary,45% benefits), 1 person for 3 years, 1.5 FTE								
Lab technician: $102,900 (63% salary, 37% fringe, 1-3 technicians for 20-40hrs/technician over 3 yrs, 2.18 FTE								
Professional/Technical/Service Contracts: *Tree care company to apply imidacloprid to soil and to inject basswood trees*	$7,000	$0	$7,000	$0	$0	$0	$7,000	$7,000
Professional/Technical/Service Contracts: *Residue analysis of imidacloprid performed at USDA AMS Lab in Gastonia, NC, EPA approved lab, cost $166/sample, 20 trees x 2 samples x 2 months x 2 yrs= 160 samples x $166 = $26,560; and 4 flowering plant species x 12 individuals x 2 samples x 2 yrs = 192 samples x$166 = $31,872; total 352 samples x $166 = $58,432 + $1568 shipping samples overnight express on dry ice*	$60,000	$0	$60,000	$0	$0	$0	$60,000	$60,000
Equipment/Tools/Supplies: Research supplies *Bumblebee colonies 120 (40/yr) @$100 each =$12,000; bee food $1,000; greenhouse space for preparing bees $3,300; flowers and trees to apply insecticides need 20 linden trees, 400 each Mexican milkweed, hummingbird mint, rugosa rose=$7,000, insecticides $1,000; field charges=$1,000; misc supplies to perform research, dry ice, storage vials, small scale $6,000*	$16,300	$0	$16,300	$14,000	$0	$14,000	$30,300	$30,300
Printing: *Reports and fact sheets for distribution at meetings*	$2,000	$0	$2,000	$0	$0	$0	$2,000	$2,000
Travel: *Instate travel to research sites, mileage for travel to and from research sites*	$3,000	$0	$3,000	$3,000	$0	$3,000	$6,000	$6,000
COLUMN TOTAL	**$276,300**	$0	**$276,300**	**$49,700**	**$0**	**$49,700**	**$326,000**	**$326,000**