



# THE USE OF INSECTICIDES TO INCREASE AVIATION SAFETY

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# BACKGROUND

- From 1995-2018 bird strikes cost the US Air Force more than \$817.5 million
- Rodents are controlled to decrease raptor presence
- Standing water is controlled to decrease waterfowl and waterbird presence
- Vegetation heights and species are controlled for birds and mammals
- What about insects?
- Many common airport bird species rely on insect forage



## ISSUE

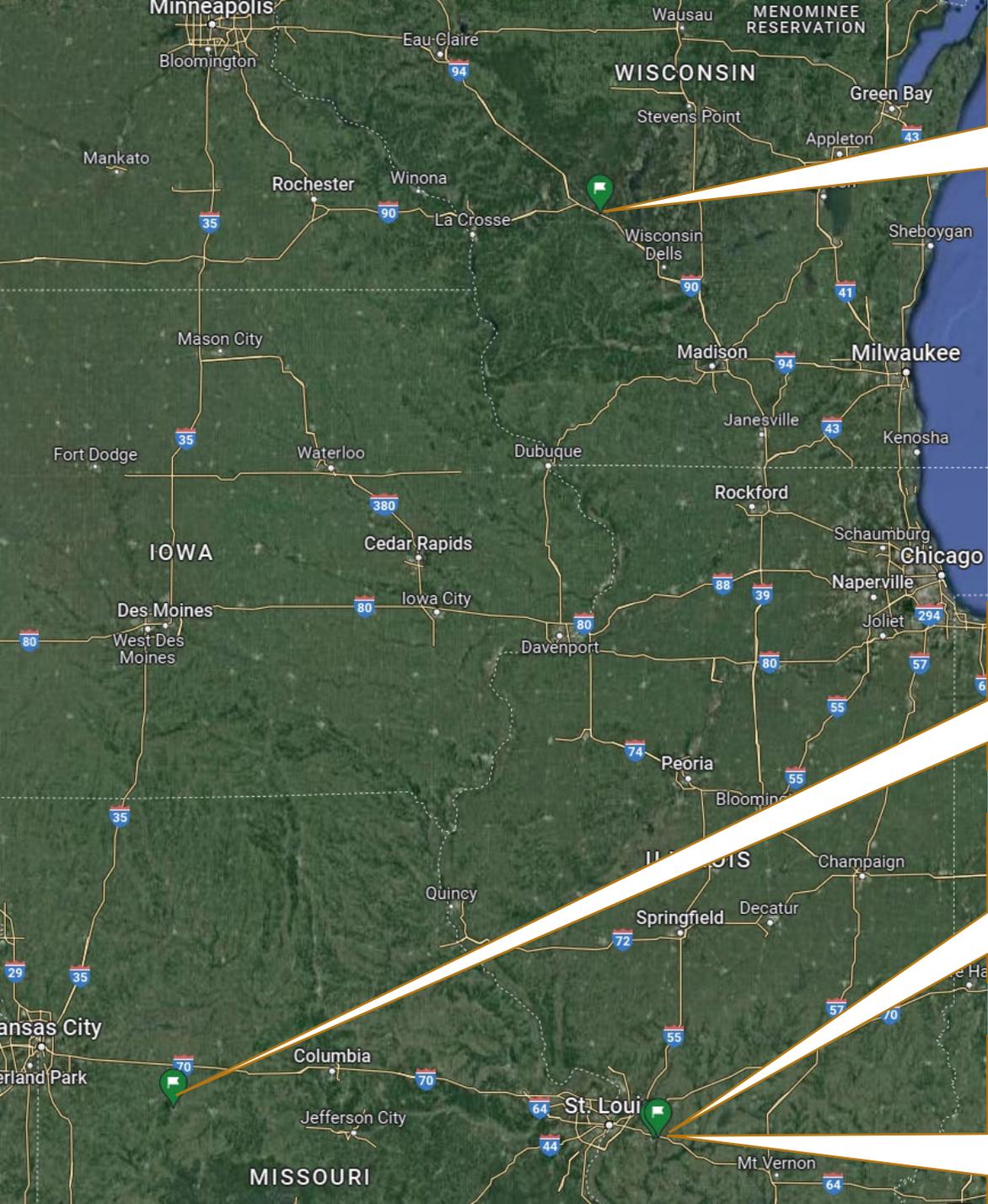
- Nearly every aspect of airfields are managed to decrease strike risks
- The creation of large expanses of grasses 7-14” tall creates an ideal habitat for some species
  - Meadowlarks, sparrows, swallows, and other insectivorous birds
- Managers often say these species do not respond well to non-lethal dispersal techniques
- So what can be done?

# OBJECTIVES

- Increase aviation safety
- Decrease forage base on airfields
  - Use insecticides to manage bird strike risk
    - Effect of different insecticides on bird abundance
    - Effect of different insecticides on insect populations
- Provide managers with relevant scientific data on the effect of insecticides on bird abundance

## METHODS OVERVIEW

- Use before/after control/treatment experiment
- Test 3 different insecticides
- Replicate across four airfields
- All airfields selected had concerns or issues with insectivorous bird species



### Volk Field

- Each site selected their own 6 study plots
  - 3 control 3 test
- Plot location and size were selected based on security protocols, CMAs, ILS areas, and other factors that would potentially impact weekly access to the plots for surveys
- Surveys were conducted from May through September 2019 and 2020

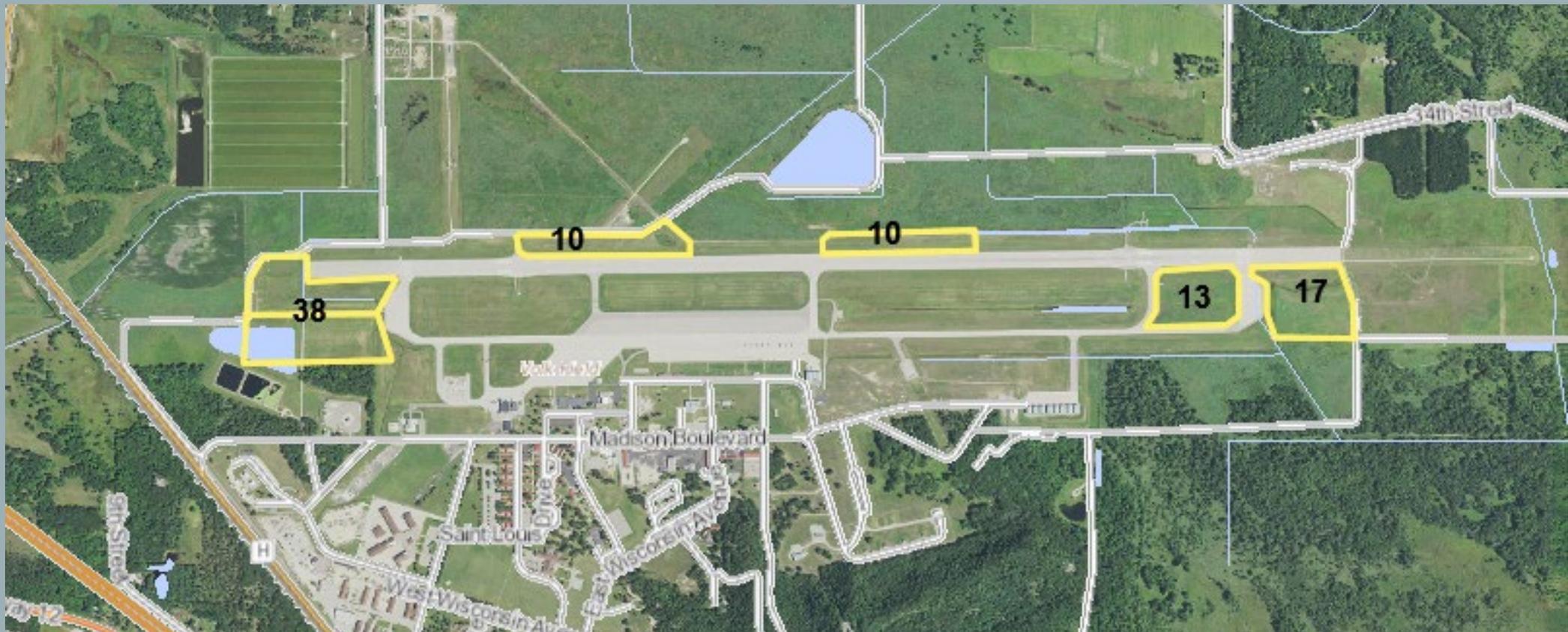
### Whiteman Air Force Base

- Year 1
  - Base year with no insecticide applications
- Year 2
  - Test year with all test plots receiving one round of a selected insecticide

### Mid American St Louis Airport

### Scott Air Force Base

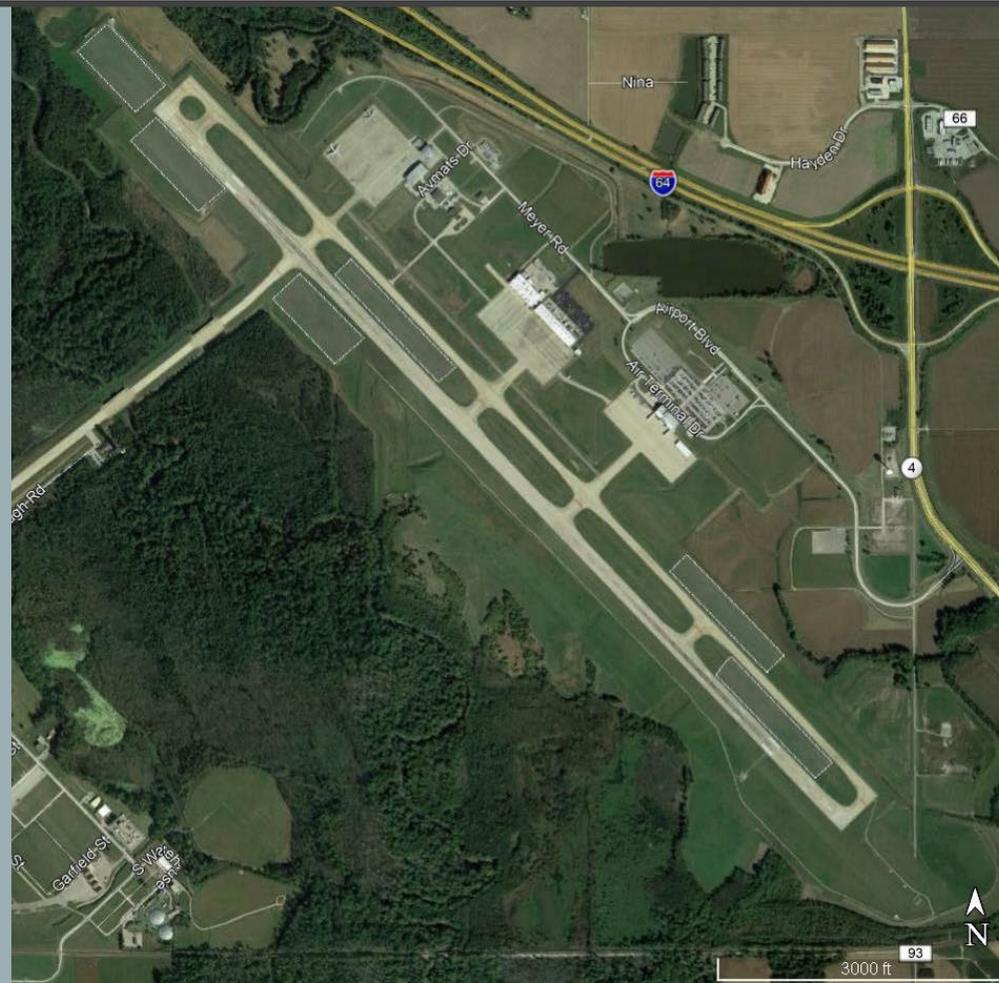
# VOLK FIELD



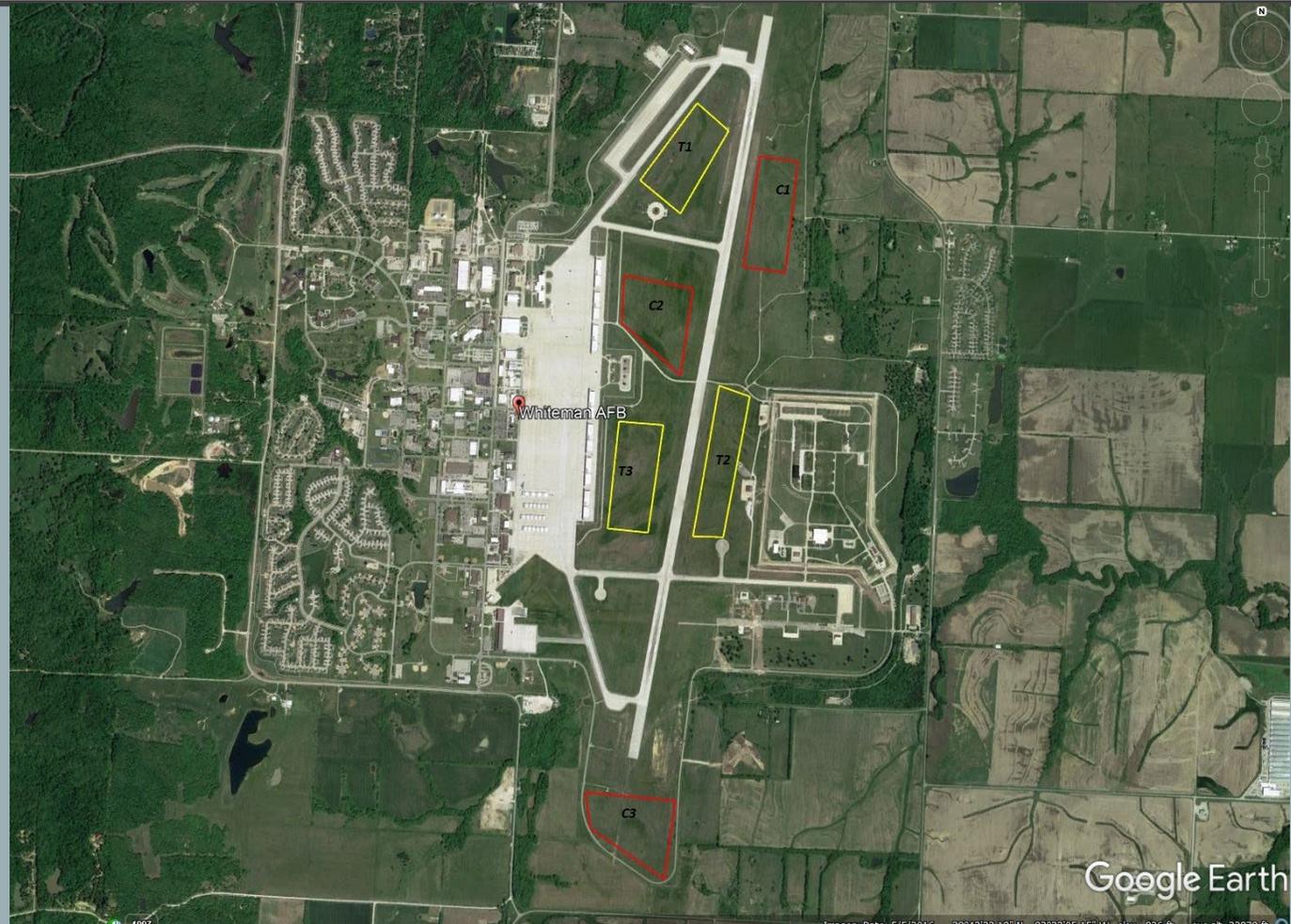
# SCOTT AIR FORCE BASE



# MIDAMERICA ST. LOUIS AIRPORT



# WHITEMAN AIR FORCE BASE



# METHODS: BIRD POINT COUNTS



- For each plot a 70m radius circle centered in the plot was used to observe bird presence and behavior
- Each plot was surveyed one day per week, with two point counts on the same day\* at random times
- Point counts lasted 3 minutes at each plot
- The species, number present, and activity of each bird located within the 70m plot were recorded
- Surveys were not conducted sooner than 2 days after mowing
- Surveys were not conducted during rain or with winds greater than or equal to 20mph



# METHODS: APPLICATION



## Sevin® SL

**CARBARYL INSECTICIDE**

*Specimen Label*

FOR AGRICULTURAL OR COMMERCIAL USE ONLY

**ACTIVE INGREDIENT:**

Carbaryl  
(1-naphthyl N-methylcarbamate) ..... 43.0% by wt.  
**INERT INGREDIENTS:** ..... 57.0% by wt.  
TOTAL ..... 100.0% by wt.

(Contains 4 pounds Carbaryl Per Gallon)

- Volk Field, Whiteman AFB
- Carbamate, leaves killing residue

**ACCEPTED**

02/11/2021

Under the Federal Insecticide, Fungicide and Rodenticide Act as amended, for the pesticide registered under EPA Reg. No. 42750-369

BIFENTHRIN GROUP 3A INSECTICIDE

**BIFENTHRIN 7.9% SC**  
TERMITICIDE/INSECTICIDE

To control pests indoors and outdoors on residential, institutional, public, commercial, and industrial buildings, greenhouses, animal confinement facilities/livestock premises, kennels, food handling establishments, and lawns, ornamentals, parks, recreational areas and athletic fields.

When used as a termiticide, individuals/firms must be licensed by the state to apply termiticide products. States may have more restrictive requirements regarding qualifications of persons using this product. Consult the pest control regulatory agency of your state prior to use of this product.

- Provides up to one-month residual control of house flies.
- Kills fleas for up to 3 months

**ACTIVE INGREDIENT:**

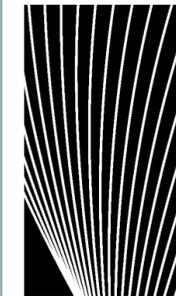
Bifenthrin\* ..... 7.9%  
**OTHER INGREDIENTS:** ..... 92.1%  
**TOTAL:** ..... 100.0%

**BY WT.**

BIFENTHRIN 7.9% SC contains 2/3 pound active ingredient per gallon.  
\*Cis isomers 97% minimum, trans isomers 3% maximum.

- Scott AFB
- Pyrethroid, leaves killing residue

## Dimilin® 2L



**Insect Growth Regulator**

**Aqueous Flowable**

For use on barley, oats, triticale, wheat, cotton, grassland and non-crop areas, leafy brassica and turnip greens, livestock/poultry premises, peanuts, pears, peppers, rice, soybeans, stonefruit (excluding cherries), tree nuts, and turfgrass

**Not for Homeowner/Residential Use**

**COMPOSITION**

**Active Ingredient:** (% by weight)

diflubenzuron ..... 22%  
N-[[[4-Chlorophenyl]amino]carbonyl]-2,6-difluorobenzamide\* ..... 78%

TOTAL ..... 100%

\*Contains 2 lbs. diflubenzuron per gallon.

\*U.S. Patent Number: 6,057,370; and 6,376,430B1 and other patents pending.

Net Contents:  
1 gallon

- MidAmerica St. Louis
- Growth regulator, may need to be ingested
- Residuals have shorter life

- Applications were made by licensed personnel employed at each location
- All permitting and NEPA compliance was conducted by base personnel
- Application dates varied based on insect immergence, development, and weather at each location

# DATA ANALYSIS: BIRDS

- All analyses are being completed in RStudio
- We used a Bayesian framework and Markov chain Monte Carlo sampling
- Bird point count models
- Hierarchical model using observations and detection probabilities
- Formed by guild analyses
  - Grassland Insectivores – ground insect foraging birds
    - Meadowlarks, sparrows, shorebirds, etc.
  - Aerial Insectivores – aerial insect foraging birds
    - Swallows, swifts, flycatchers, etc.



# DATA ANALYSIS: BIRDS

- Random effects for:
  - Site
  - Observer
- Days since treatment – DST
  - Counts the number of days since an insecticide treatment was applied
  - DST was used to track abundance as days pass after the application of different insecticides
  - We needed to capture how the 3 different insecticides used affect insects populations differently
- Time of day

$$Y_{ij} \sim \text{Binomial}(N_i, p_{ij})$$

$$\text{logit}(p_{ij}) = \alpha + \beta * \omega_{ij},$$

$$N_i \sim \text{Poisson}(\lambda)$$

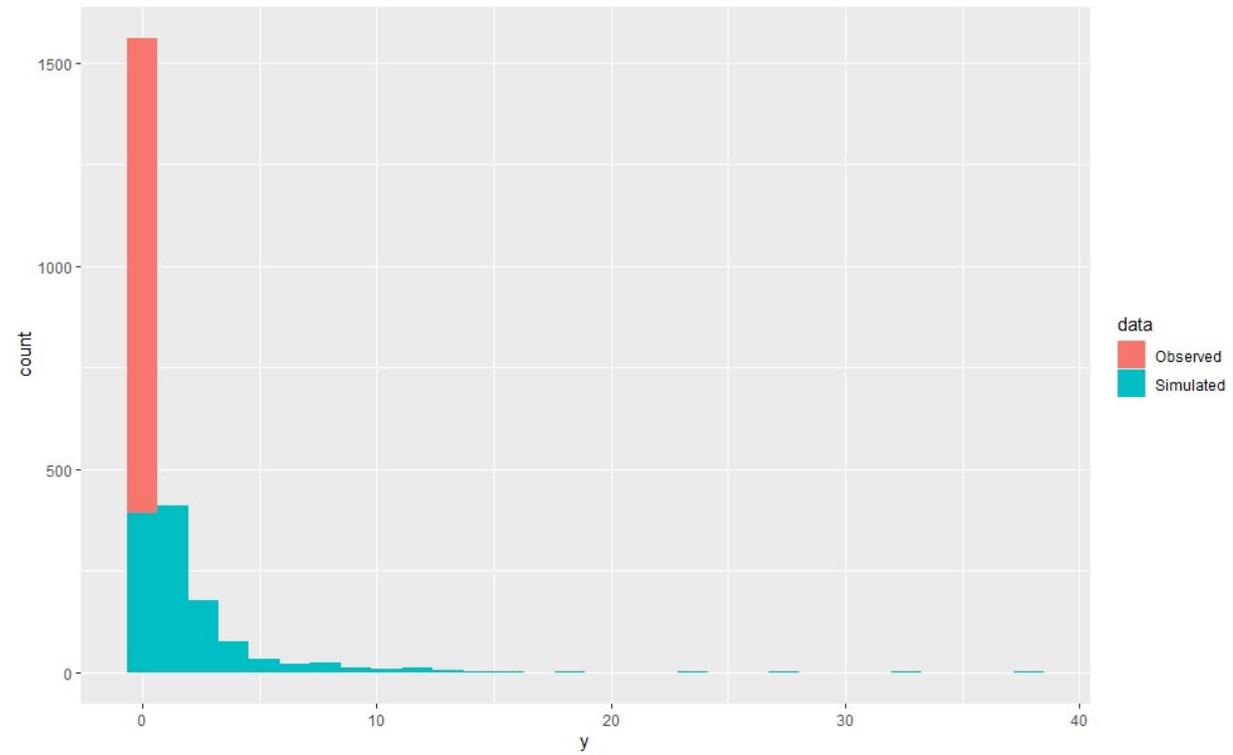
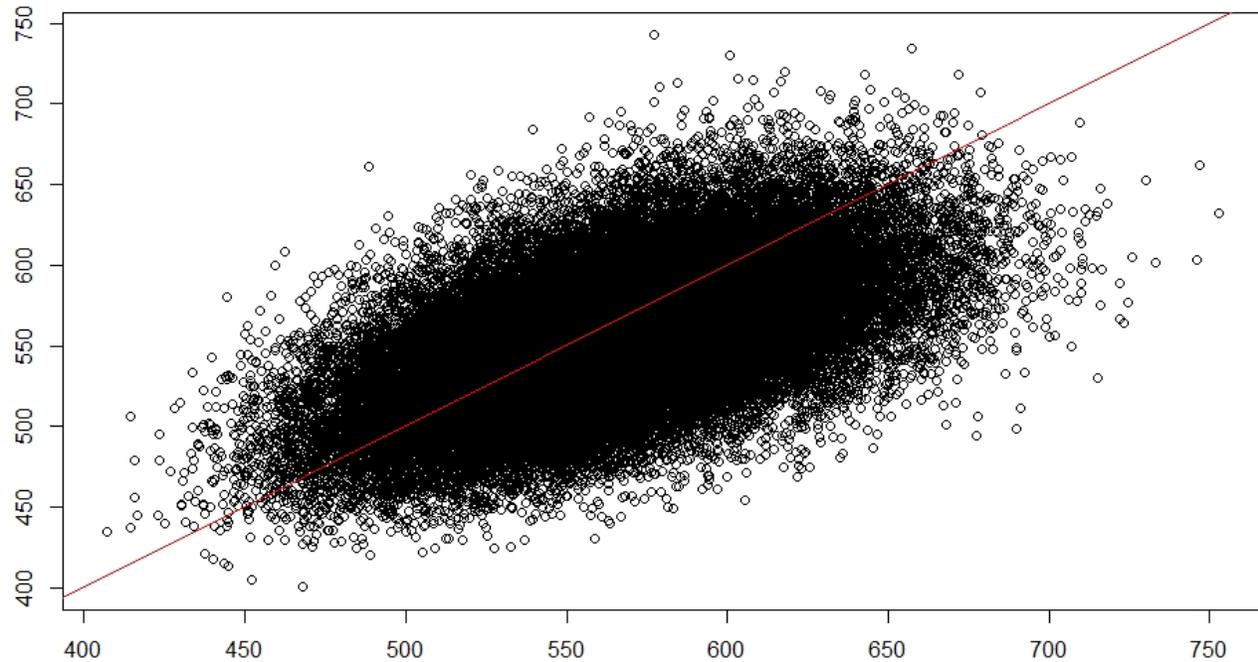
$$\log(\lambda_i) = \alpha + \beta * x_i$$

## METHODS: GRASSLAND AND AERIAL

- Bayesian specifics
  - Number of chains = 3
  - Number of iterations = 100,000
  - Number of burn-ins = 20,000
  - Thin rate = 5
- The effect for days since treatment was held at 0 for control plot observations
- Non informative priors

# MODEL STRENGTH: GRASSLAND INSECTIVORES

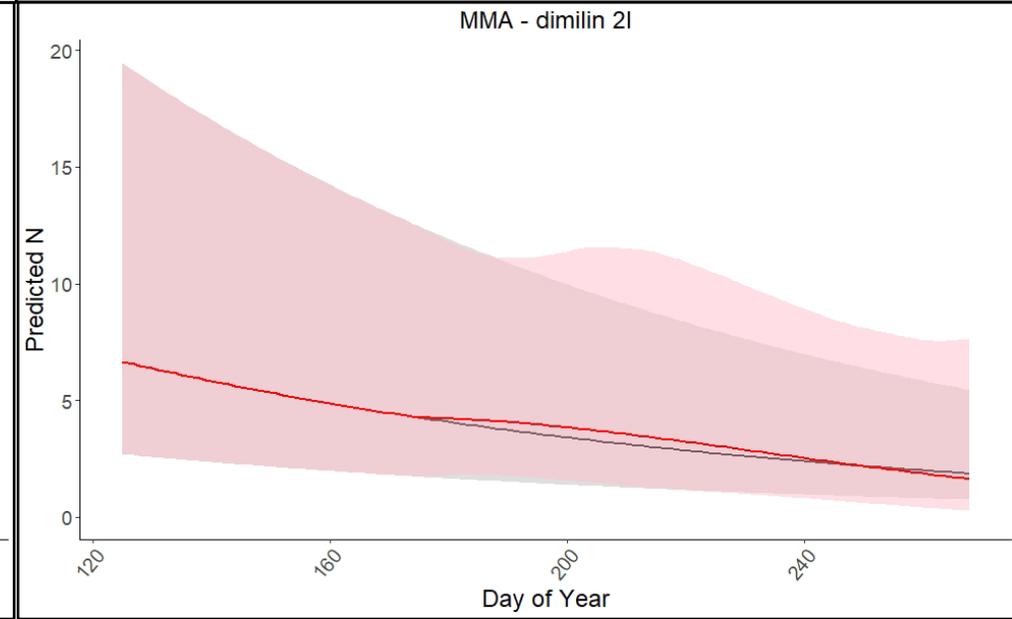
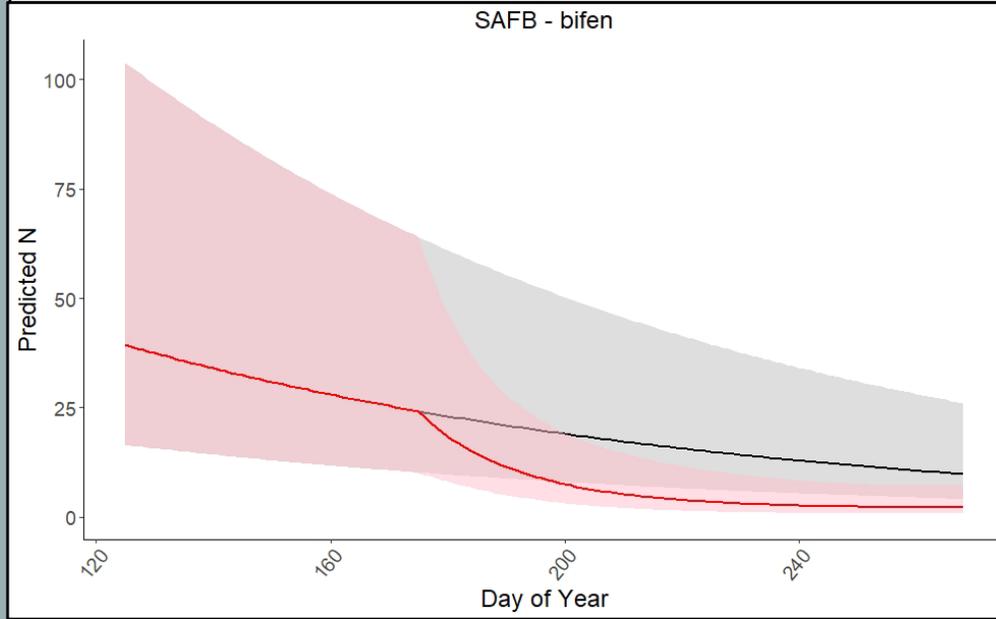
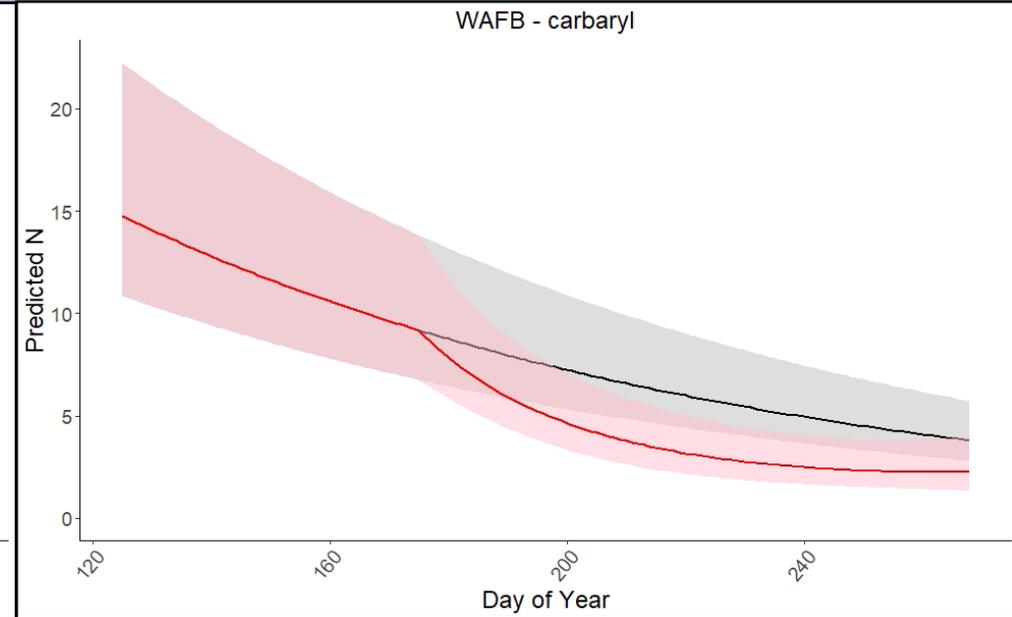
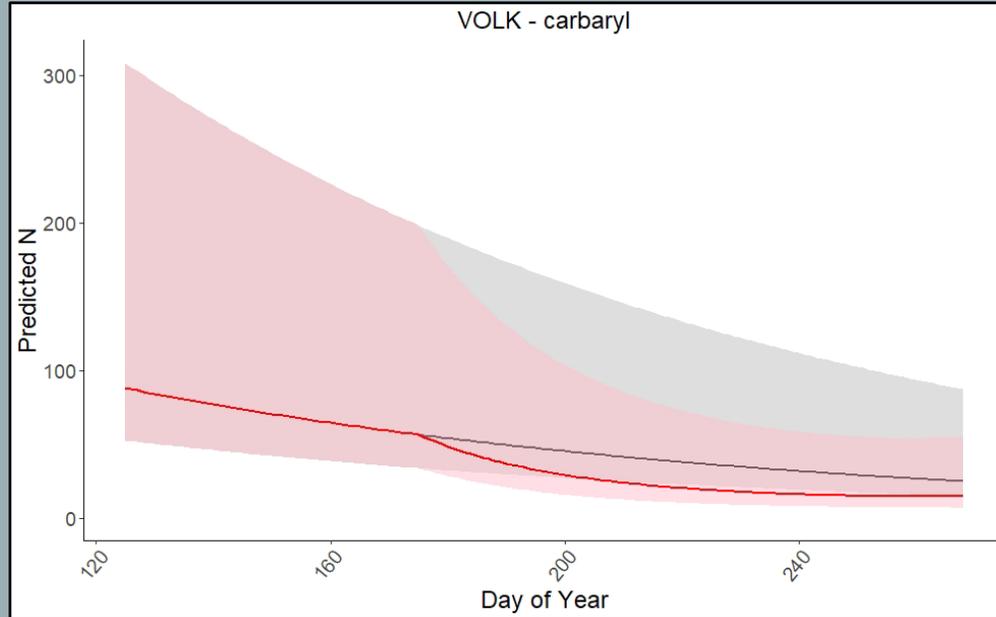
Bayesian P-value: 0.411



## GRASSLAND INSECTIVORE RESULTS

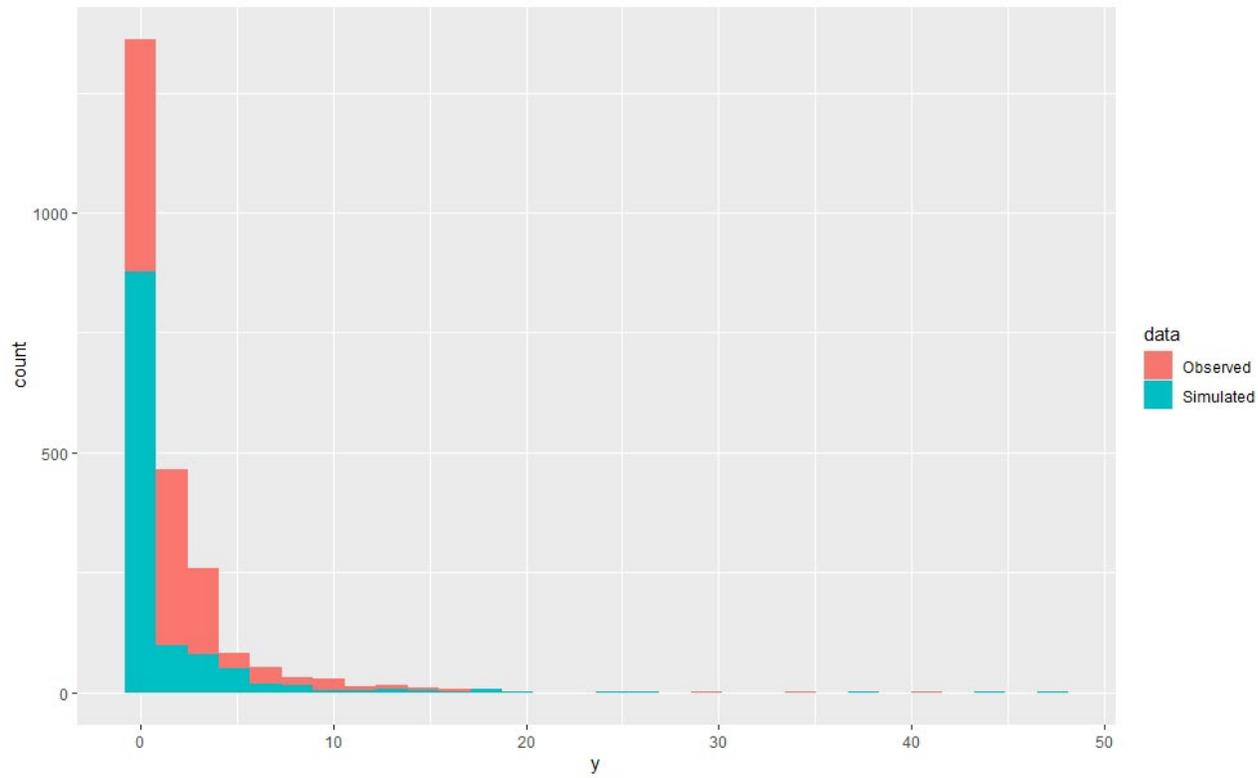
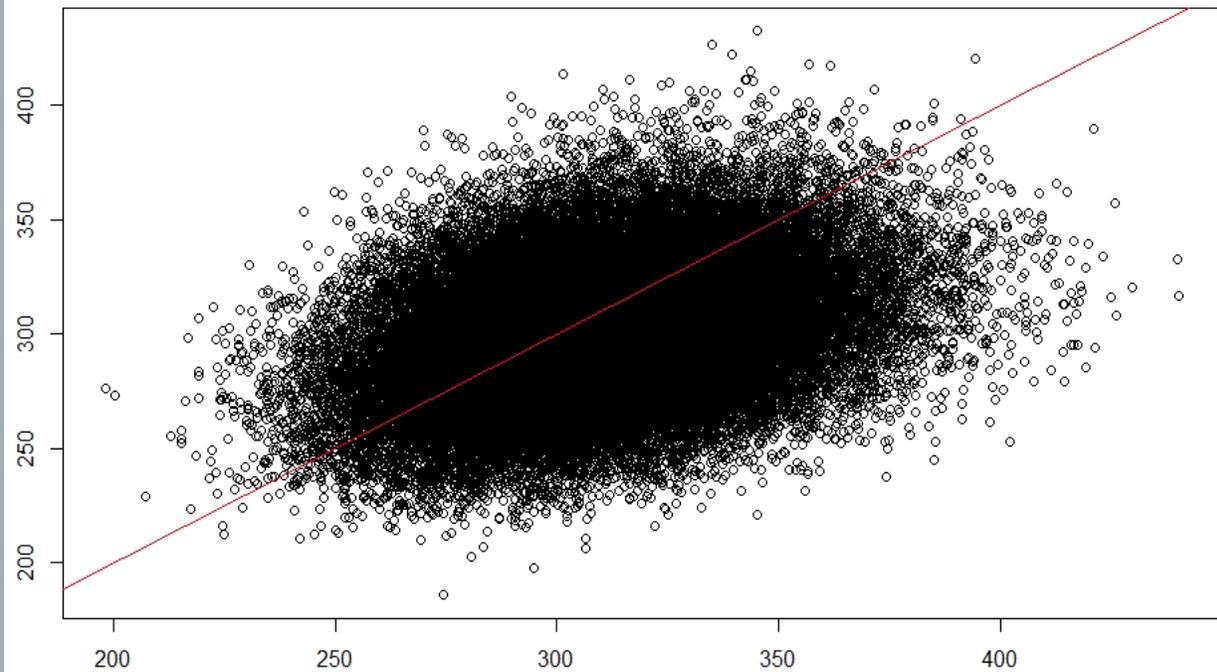
	mean	2.5%	97.5%	f
beta.time	-0.28	-0.40	-0.16	1.00
Beta DOY MMA	-0.27	-0.66	0.11	0.92
Beta DOY SAFB	-0.13	-0.41	0.16	0.81
Beta DOY VOLK	-0.37	-0.51	-0.24	1.00
Beta DOY WAFB	-0.29	-0.39	-0.18	1.00
Beta DST Control	0.00	0.00	0.00	1.00
Beta DST Bifen	-1.06	-1.79	-0.32	1.00
Beta DST Carb	-0.50	-0.77	-0.23	1.00
Besa DST Dimilin	0.14	-0.74	1.01	0.63
Beta2 DST Control	0.00	0.00	0.00	1.00
Beta2 DST Bifen	0.27	0.04	0.50	0.99
Beta2 DST Carb	0.15	0.03	0.26	0.99
Bets2 DST Dimilin	-0.08	-0.48	0.29	0.66

# GRASSLAND INSECTIVORE RESULTS



# MODEL STRENGTH: AERIAL INSECTIVORES

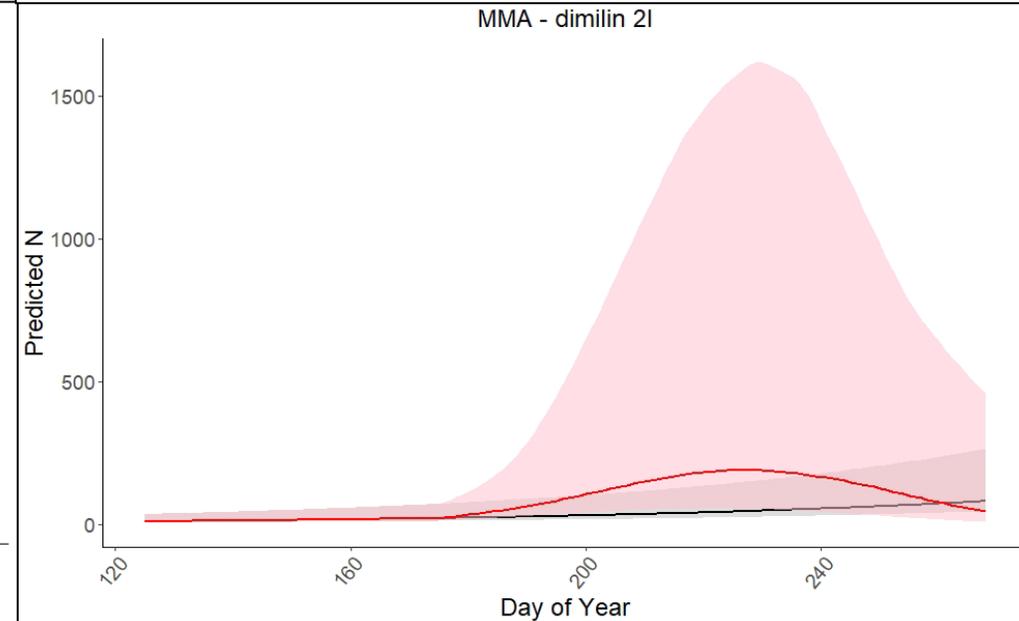
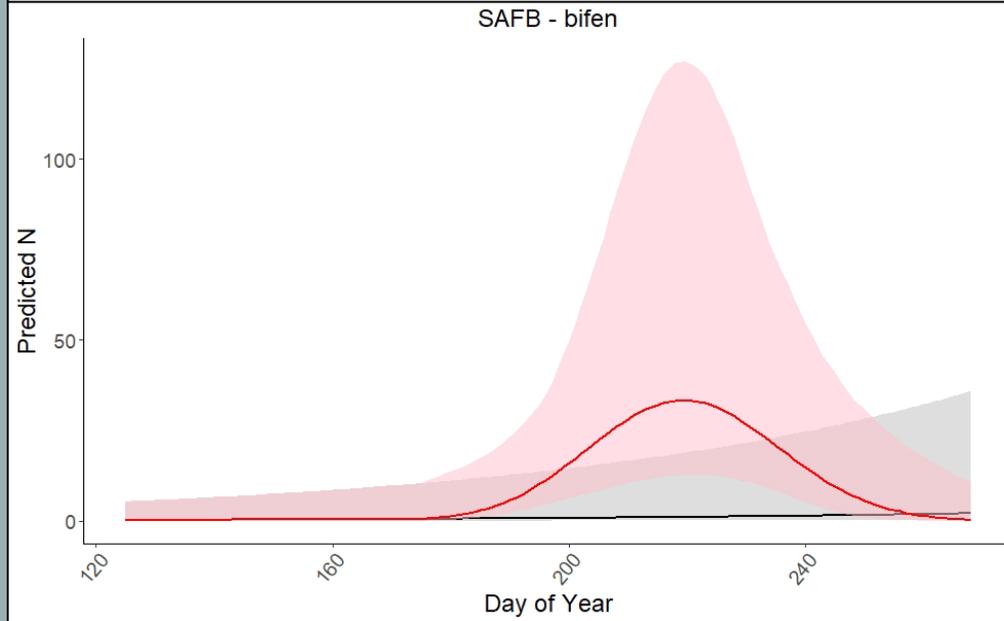
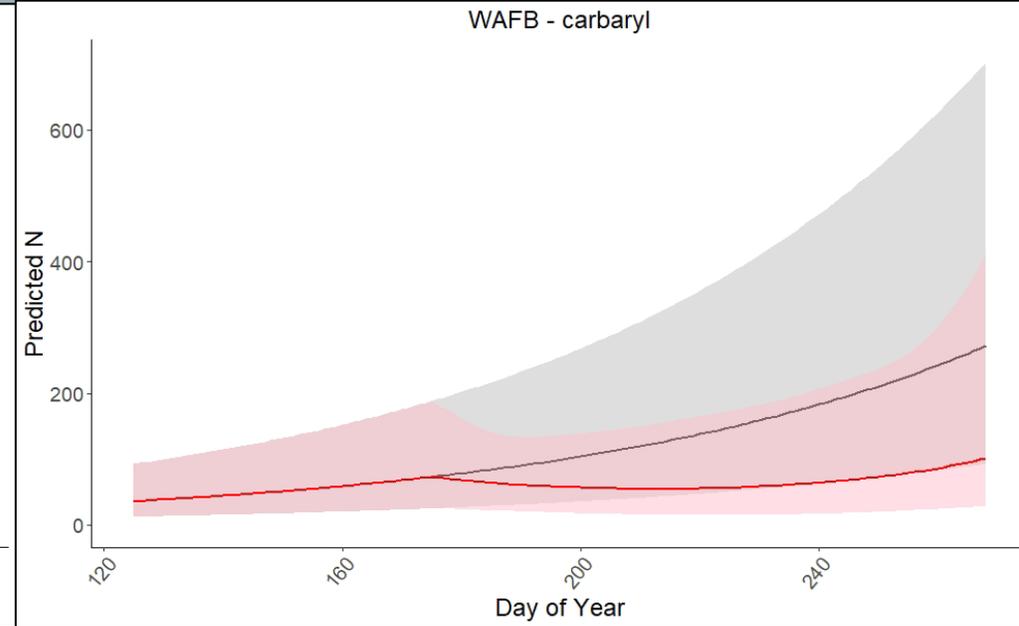
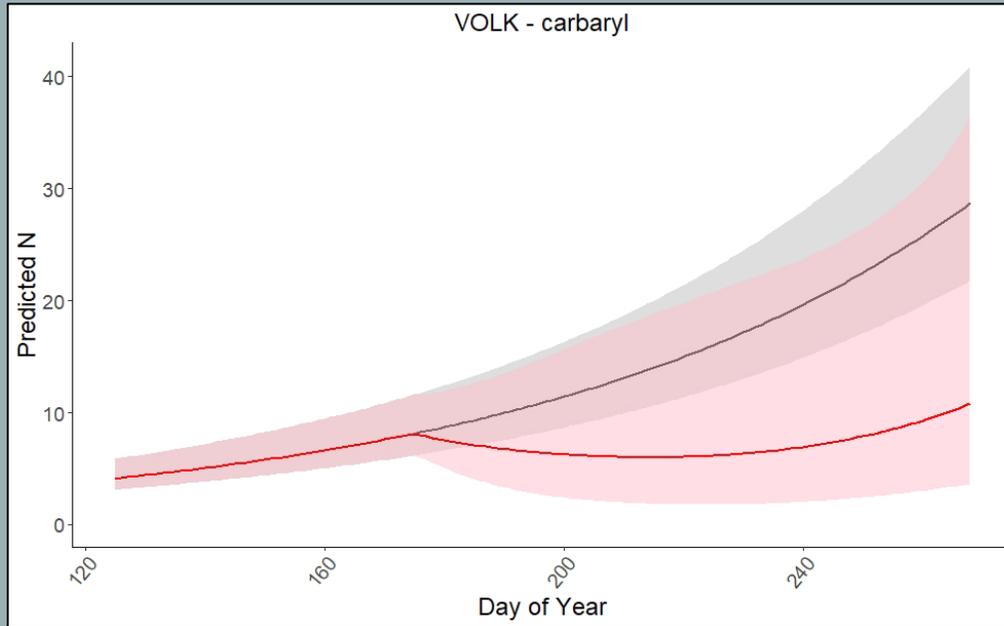
Bayesian P-value: 0.386



# AERIAL INSECTIVORE RESULTS

	mean	2.5%	97.5% f	
beta.time	-0.26	-0.53	0.00	0.98
Beta DOY MMA	0.51	-0.22	1.05	0.93
Beta DOY SAFB	0.72	-0.06	1.57	0.96
Beta DOY VOLK	-0.36	-0.70	-0.06	0.99
Beta DOY WAFB	-0.43	-0.77	0.05	0.96
Beta DST Control	0.00	0.00	0.00	1.00
Beta DST Bifen	3.15	0.56	5.61	0.99
Beta DST Carb	-0.71	-1.63	0.17	0.95
Besa DST Dimilin	1.45	0.40	2.63	1.00
Beta2 DST Control	0.00	0.00	0.00	1.00
Beta2 DST Bifen	-1.63	-2.91	-0.44	1.00
Beta2 DST Carb	0.18	-0.15	0.57	0.84
Bets2 DST Dimilin	-0.71	-1.24	-0.22	1.00

# AERIAL INSECTIVORE RESULTS

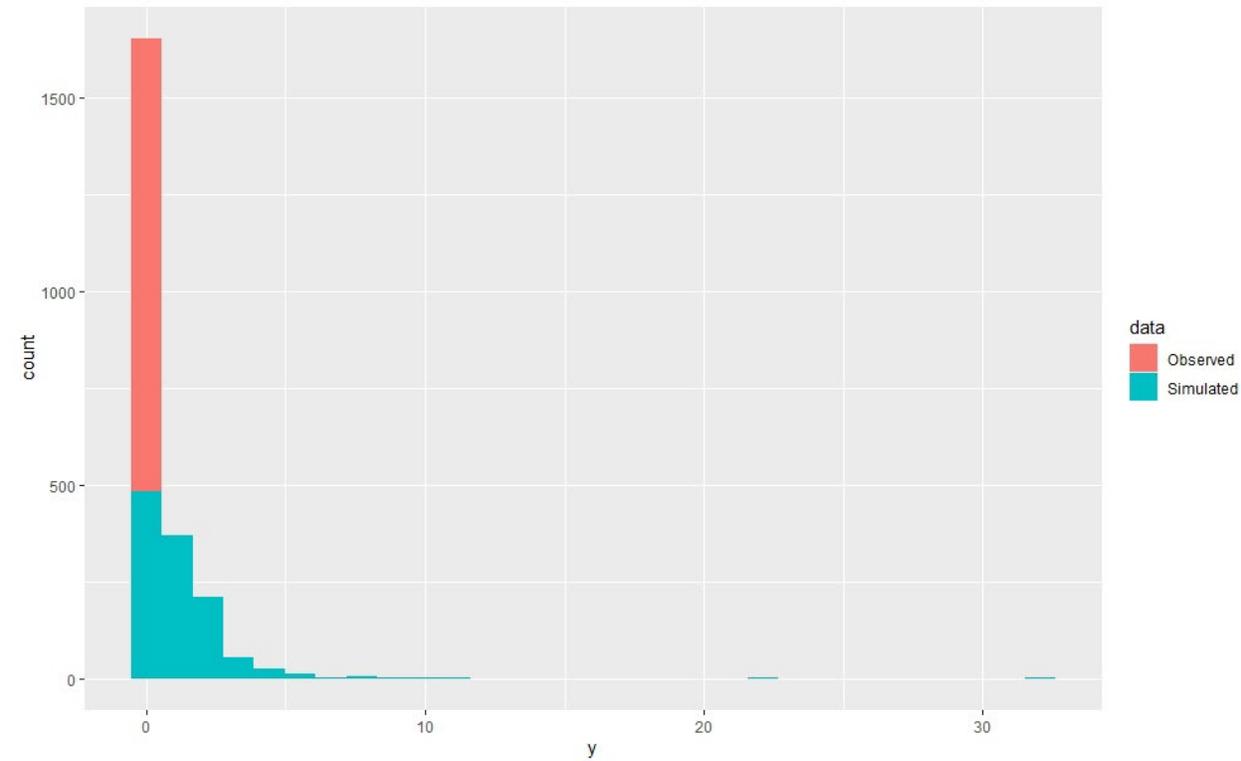
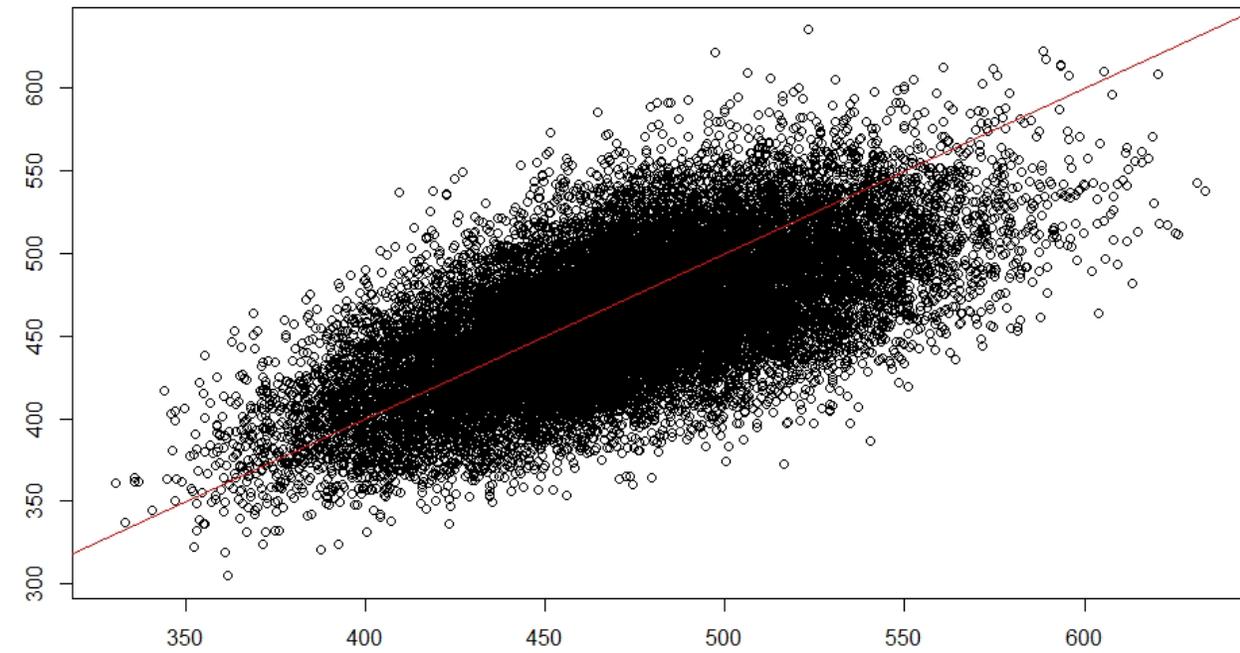


## METHODS: EASTERN MEADOWLARK

- Bayesians specifics
  - Number of chains = 3
  - Number of iterations = 50,000
  - Number of burn-ins = 20,000
  - Thin rate = 5
- Days since treatment was held at 0 for control plot observations
- Non informative priors
- Included `beta.treatment`

# MODEL STRENGTH EASTERN MEADOWLARK

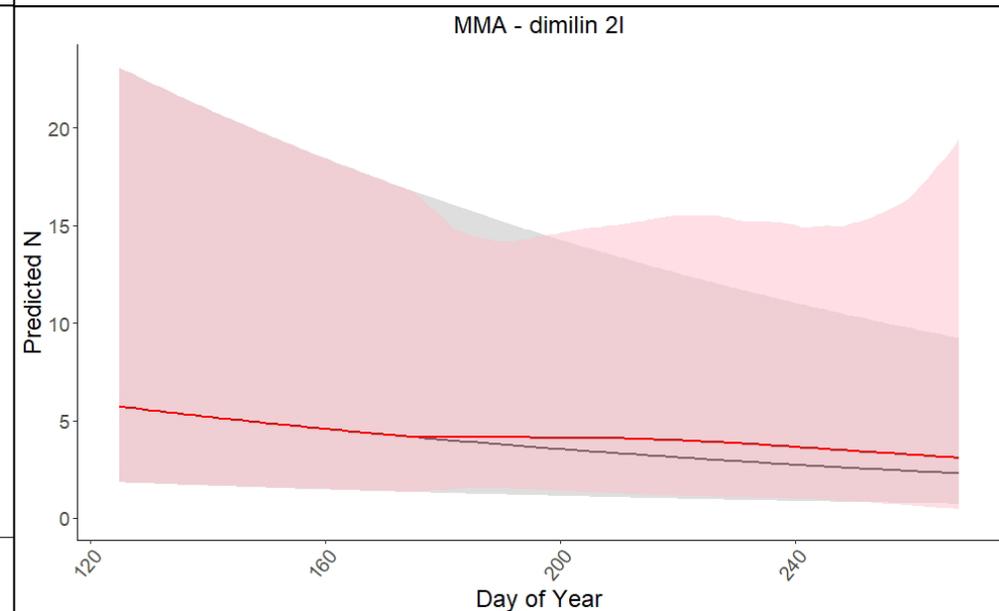
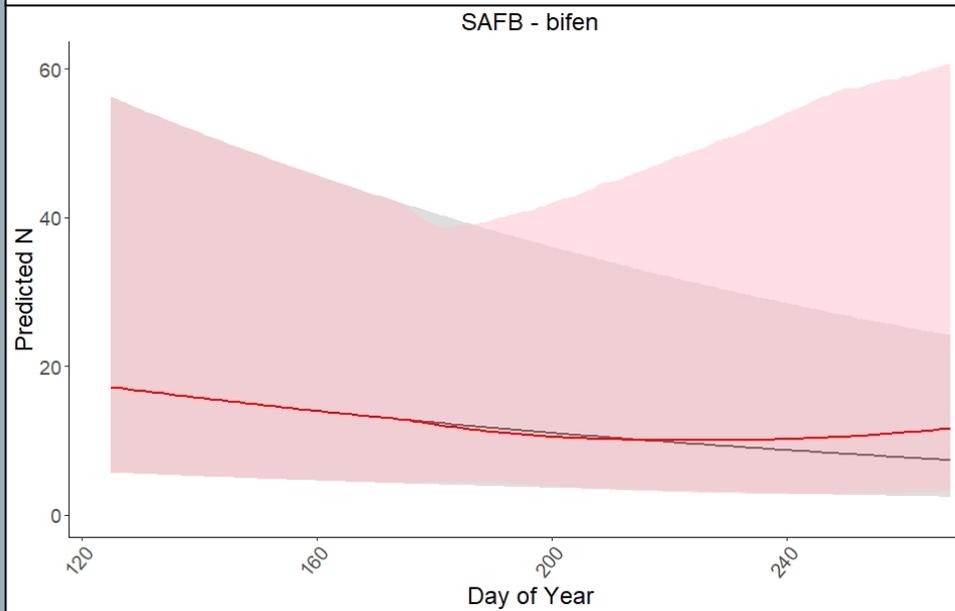
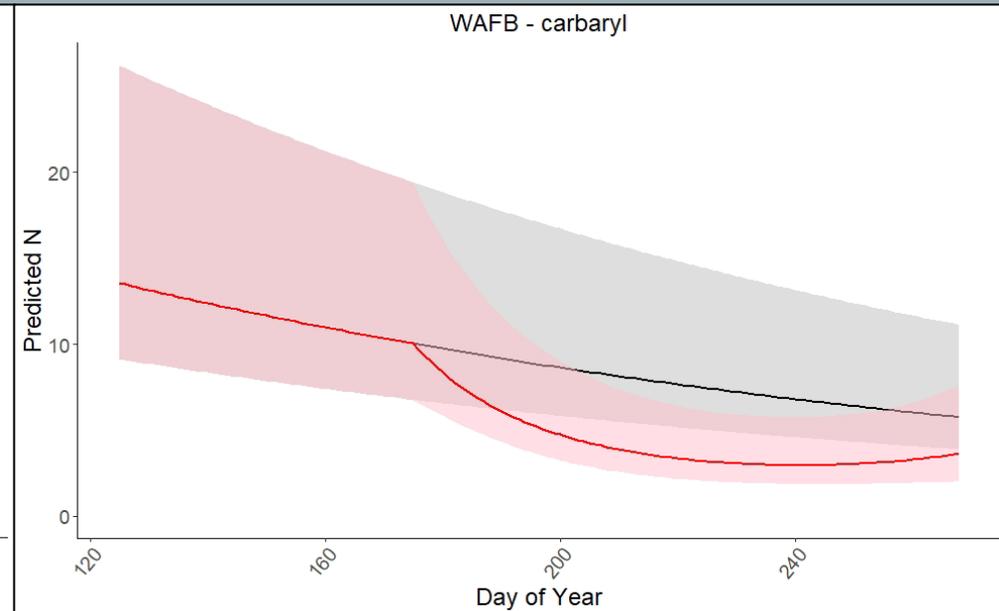
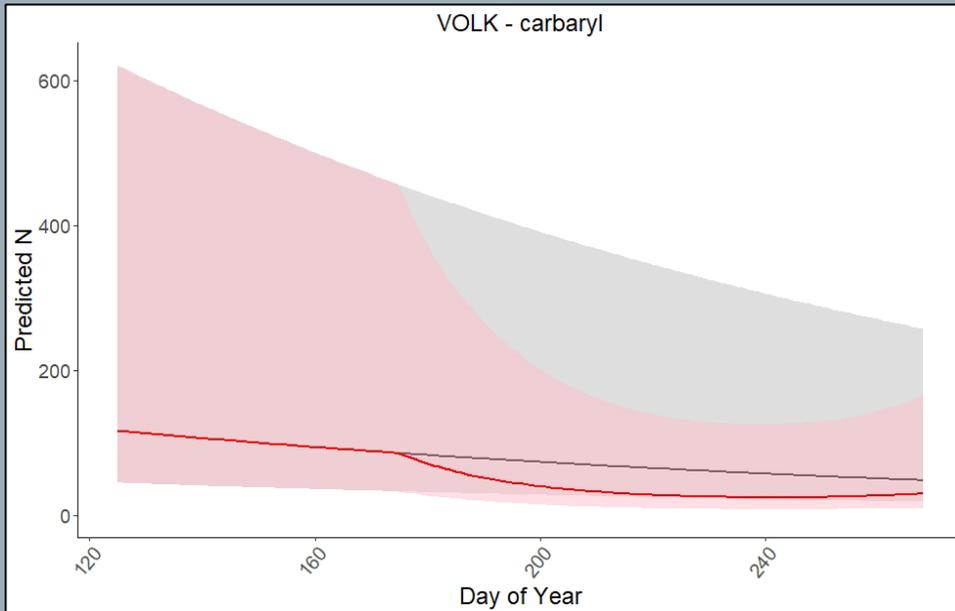
Bayesian P-value: 0.386



## EASTER MEADOWLARK RESULTS

	mean	2.5%	97.5%	f
beta.time	-0.26	-0.41	-0.13	1.00
beta.doy	-0.19	-0.28	-0.10	1.00
Beta Treatment Control	0.00	0.00	0.00	1.00
Beta Treatment Bifen	-1.21	-1.98	-0.49	1.00
Beta Treatment Carb	-0.38	-0.65	-0.12	1.00
Beta Treatment Dimilin	-0.62	-1.33	0.10	0.96
Beta DST Control	0.00	0.00	0.00	1.00
Beta DST Bifen	-0.02	-0.97	0.94	0.51
Beta DST Carb	-0.69	-1.04	-0.34	1.00
Beta DST Dimilin	0.18	-0.83	1.17	0.64
Beta2 DST Control	0.00	0.00	0.00	1.00
Beta2 DST Bifen	0.07	-0.20	0.35	0.68
Beta2 DST Carb	0.23	0.09	0.38	1.00
Beta2 DST Dimilin	-0.04	-0.51	0.40	0.56

# EASTERN MEADOWLARK RESULTS



## WHAT DO THE RESULTS MEAN?

- Carbaryl and Bifen show significant decreases in grassland insectivore abundance
- Carbaryl significantly decreased aerial insectivore abundance at both sites
- Carbaryl significantly decreased Eastern meadowlarks at both sites
- Decreased bird abundance showed shortly after application and continued through 100 days after application
- Different chemicals have different effects over time
  - Growth inhibitors did not show a decrease in abundance
  - Carbaryl showed decreases for both AI and GI and Bifen showed a decrease for GI

# INSECTS

- All analyses are being completed in RStudio
- I will use the same Bayesian framework and Markov chain Monte Carlo sampling
- By Order analysis
- I will continue to focus on the days since treatment covariate

## METHODS: INSECT SAMPLING

- Each plot was sampled once weekly
- One plot sample included a total of 5 sweep-net samples
  - One sweep net sample – 10 paces turn 90°, 5 paces turn 90°, and 10 paces
  - For each sweep net sample the average vegetation height was recorded
- Contents from the plot samples were dumped into ziplock bags and labeled accordingly
  - Samples were then frozen for future identification
- Sweep nets were standardized with 15” hoop nets
- Sweep nets were drug along the sampler with no sweeping chasing actions



# INSECT IDENTIFICATION

- Insects were identified to Order and Family in most circumstances
  - Lepidoptera larva were only identified to order
  - Parasitic wasps and sawflies were only identified to “parasitic wasp and sawflies”
- Insects were identified in labs under microscopes with keys and the Kaufman Guide to North American Insects



# METHODS: APPLICATION REVISITED



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Specimen Label

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TOTAL ..... 100.0% by wt.

(Contains 4 pounds Carbaryl Per Gallon)

- Volk Field, Whiteman AFB
- Carbamate, leaves killing residue

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- Provides up to one-month residual control of house flies.
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**OTHER INGREDIENTS:** ..... 92.1%  
**TOTAL:** ..... 100.0%

**BY WT.**

BIFENTHRIN 7.9% SC contains 2/3 pound active ingredient per gallon.  
\*Cis isomers 97% minimum, trans isomers 3% maximum.

- Scott AFB
- Pyrethroid, leaves killing residue

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**Insect Growth Regulator**

**Aqueous Flowable**

For use on barley, oats, triticale, wheat, cotton, grassland and non-crop areas, leafy brassica and turnip greens, livestock/poultry premises, peanuts, pears, peppers, rice, soybeans, stonefruit (excluding cherries), tree nuts, and turfgrass

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**COMPOSITION**

**Active Ingredient:** (% by weight)

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TOTAL ..... 100%

\*Contains 2 lbs. diflubenzuron per gallon.

\*U.S. Patent Number: 6,057,370; and 6,376,430B1 and other patents pending.

Net  
Contents:  
1  
gallon

- MidAmerica St. Louis
- Growth regulator, may need to be ingested
- Residuals have shorter life

- Applications were made by licensed personnel employed at each location
- All permitting and NEPA compliance was conducted by base personnel
- Application dates varied based on insect immergence, development, and weather at each location

## EFFECTS ON MANAGEMENT

- Airfields with GI guild bird issues can apply a contact insecticide such as carbaryl or bifenthrin to decrease insectivore abundance for a minimum of 100 days
- Airfields with AI guild bird issues can apply carbaryl to decrease bird abundance for a minimum of 100 days
  - Bifenthrin and dimilin did not show decreased abundance and showed an increase that may be related to a few outlier observations
- This research has provided hard data to support the use of insecticides as an effective management tool
- Co-applications of rodenticides and specific insecticides can cooperatively reduce overall bird abundance in an airfield environment
- Possible environmental effects?

# QUESTIONS?

A sincere thank you to Phil Peterson – Volk Field and Kevin Wedemeyer – SAFB/MidAmerica for the two seasons of hard work insect collecting and bird surveying

Thank you to the staffs at Volk Field, Scott Air Force Base, MidAmerica, and Whiteman Air Force Base for their willingness to participate and their time and monetary contributions so this study could be successfully completed

Thank you to my Coauthors Dr. Thomas Bonnot and Dr. Brian Washburn

Thank you to Curtis Holliday and Mary Benoit for lab work identifying insects

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