FINAL REPORT

TITLE

Demonstrating and Quantifying the Influences of Incentive Based Rest Rotation Grazing on Food Insects of Sage-Grouse, Rangeland Pollinators, and Vectors of West Nile Virus.

PROJECT DURATION

September 1, 2014 – August 31, 2016

PROJECT DIRECTOR:

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PROJECT STATUS: COMPLETED

EXECUTIVE SUMMARY (FROM THE 2014 PROPOSAL)

Populations of sage-grouse, an iconic western rangeland bird, have been in decline since the 1950s. In 2010, the United States Fish and Wildlife Service indicated that sufficient evidence exists to warrant listing sage-grouse on the Endangered Species List; however other species were of greater concern. It is estimated that listing sage-grouse as an endangered species will cost western rural states and communities billions of dollars annually. In light of this ecological and economical concern, a 5-year moratorium was placed on sage-grouse endangered status so that state, federal, and private sector representatives could begin identifying and implementing conservation strategies aimed at stabilizing sage-grouse populations. One of the programs which developed is the Natural Resource Conservation Service's Sage-Grouse Initiative (SGI) which is a voluntary incentive based system in which ranchers can enroll their land. The target of the SGI is promoting sage-grouse conservation practices across the western U.S while keeping ranches profitable and native landscapes intact. One of the SGI programs is a rest rotation cattle grazing program. Ideally, rest rotation cattle grazing produces higher quality sage-grouse nesting cover and ultimately chick and brood survival.

Although it is unclear exactly what is driving the decline in sage-grouse, much research indicates that chick and brood survival is directly linked to recruitment into the adult breeding population. One thing which is known to positively drive chick and brood survival is the abundance of arthropods (insets, spiders, etc.) near brooding locations. Sage-grouse chicks are nearly 100% dependent on these arthropods as a sole source of food for the first 21-28 days of life. Without sufficient abundances on which to feed, chicks will die. Another component of chick and brood survival is the distribution of West Nile virus, a deadly infection transmitted to sage-grouse by mosquitos.

Populations of pollinators (bees, butterflies, moths, etc.) have also been in decline in recent years. Pollinators provide a yearly economic service to agriculture, through crop and rangeland plant pollination, which has been estimated at $5.7 billion. A key component to high quality pollinator habitats is an abundance and diverse array of flowering plants. On rangelands, pollinators are a key component and provide essential services to the plant communities on which sage-grouse and their food arthropods depend.

Our team has conducted research for the past two years and we are finding that both food arthropods and pollinators benefit from the same land management practices. Specifically, our results indicate that the SGI rest rotation cattle grazing program not only increases the abundance of food arthropods but that it also increases the abundance of pollinators in years with near normal precipitation. Other research currently being conducted in our central Montana location indicates that sage-grouse nest success is also higher in pastures enrolled in the SGI.

Ultimately, some linkages are becoming clear in that sage-grouse, food arthropods, and pollinators are dependent on similar habitat qualities. As a result of the findings, we are requesting NRCS Conservation Innovation Grant funding to further evaluate and demonstrate the benefits of rest rotation cattle grazing by developing metrics which land managers can use to assess food arthropod and pollinator habitat quality based on the vegetation diversity and structure. As part of this we also propose to evaluate the distributions of vectors of West Nile virus based on the rest rotation grazing program. These will be incorporated into land management practices which will also help keep ranches profitable and native landscapes, on which rangeland species depend, intact for future generations.

PRIMARY AREAS FOR CONSIDERATION:

- **Wildlife**. The U.S. Fish and Wildlife Service (FWS) has concluded that the greater sage-grouse warrants protection under the Endangered Species Act and that Pollinator species are declining at an alarming rate. Pollinators (mostly insects) pollinate over 75% of our flowering plants, including many forbs classified as sage-grouse food.
- When sagebrush steppe habitats are converted to crop land, both sage-grouse and wild pollinators loose vital habitat. Conversion is primarily to wheat, which is wind pollinated, and is considered non-habitat for both sage-grouse and pollinators.
- Threats in common to sage-grouse, sage-grouse food insects, and wild pollinators are habitat loss, degradation, and fragmentation through loss of critical habitat.
- Furthermore, West Nile virus, an additional threat to sage-grouse, has been detected in our project location and quantifying rest rotation influence on the vectors of this virus is needed.
- We will:
    - Demonstrate and quantify the impacts of grazing as a habitat management tool.
    - Address the NRCS High Priority: Pollinators per unit area of rest rotation grazed sagebrush steppe habitats under threat of conversion to wheat fields.
    - Demonstrate new techniques and/or technologies for monitoring and evaluating wildlife habitat onsite and via remote sensing.

a. Objectives:

1) Demonstrate and quantify the benefits of rest rotation livestock grazing as a habitat management tool of food insects and wild pollinator species.

- Objective complete: A comprehensive data set necessary to meet Objectives/Deliverable was collected

2) Quantify sage-grouse food insects/pollinators across varying vegetative communities by documenting abundances according to levels of sagebrush, grass, and forb canopy cover in relations to percentage bare ground.

- Objective complete: Arthropod data were collected along with the associated vegetative community and bare ground metrics.
- Deliverable complete: These data were used to produce the deliverables associated with bullet #4 below.

3) Quantify the abundances of West Nile virus vectors in rested and grazed pastures and generate risk assessments.

- Objective complete: Data was generated to quantify the diversity of West Nile virus vectors and estimate yearly risk factors in an area of Montana which has yet to be sampled.
- Deliverable complete: Data were pooled with the Montana Mosquito Surveillance program as an early warning system to land managers and wildlife agencies as to the potential for a West Nile virus outbreak in our project area.

Deliverable: Our team was presented with the opportunity to contribute West Nile vector specimens to the Montana Mosquito Surveillance found here: https://django.msu.montana.edu/MTmosquito/. We capitalized on this opportunity and replace collecting vectors from a grazed and rested pasture with 1) processing specimens collected in 2013 and 2) trapping a new Montana location from which data had yet to be collected.

Our efforts resulted in novel data from Musselshell and Golden Valley counties in Montana. Eleven mosquito species were collected at the Lehfeldt site (Fig. 1) while 18 species were collected from the Musselshell River site (Fig. 2). *Aedes dorsalis* dominated the collections at both sites at 74.9% (700 specimens) (Fig.1) and 65.8% (2,505 specimens) (Fig. 2). *Culex tarsalis*, one of the main competent vectors of West Nile Virus, was second in abundance and collected at 18.2% (691 specimens) from the Musselshell River site during 2013. This site sits on the southern edge of the central Montana sage-grouse core area and has potential of being a point of concern for sage-grouse populations during years of West Nile virus outbreaks.

Seven mosquito species were collected from the Lake Mason trapping site where *Culex Tarsalis* was also recorded as second in abundance at 20.2% (17 specimens) (Fig. 3). This location sits in the middle of the central Montana sage-grouse core area and could pose a serious

threat to sage-grouse populations during years of West Nile virus outbreak. The trapping site is a low-lying lake with sagebrush steppe habitats abutting the lake shore.

County: Golden Valley

Site: Lehfeldt

Year: 2013, 13 Trap Night

Species	Total Counted	%
Ae. dorsalis	700	74.9
Ae. campestris	120	12.8
Ae. nigromaculis	45	4.8
Ae. s. spencerii	27	2.9
Cx. tarsalis	23	2.5
Ps. signipennis	11	1.2
Ae. melanimon	4	0.4
Ae. niphadopsis	2	0.2
Cs. inornata	1	0.1
Ae. vexans	1	0.1
Ae. s. idahoensis	1	0.1

County: Golden Valley

Site: Musselshell River

Year: 2013, 7 Trap Nights

Species	Total Counted	%
Ae. dorsalis	2505	65.8
Cx. tarsalis	691	18.2
Ae. vexans	382	10.0
Ae. melanimon	175	4.6
Cs. inornata	16	0.4
Ae. campestris	8	0.2
Ae. cinereus	6	0.2
Ps. signipennis	5	0.1
Ae. s. idahoensis	4	0.1
Ae. nigromaculis	4	0.1
Ae. s. spencerii	3	0.1
Ae. sticticus	2	0.1
Ae. trivittatus	1	0.0
Cx. pipiens	1	0.0
Ae. flavescens	1	0.0
An. freeborni	1	0.0
Cs. morsitans	1	0.0
Ae. hendersoni	1	0.0

Figure 1 (left) and Figure 2 (right) of Mosquito species rank abundance and percent rank from Lehfeldt and Musselshell trapping site during field season 2013. Specimes were collected prior to

the NRCS CIG award; however, resources were used to process these and contribute them to the Montana Mosquito Survaleance Program.

County: Musselshell

Site: Lake Mason

Year: 2013, 2 Trap Nights

Species	Total Counted	%
Ae. dorsalis	44	52.4
Cx. tarsalis	17	20.2
Ae. nigromaculis	12	14.3
Ae. s. spencerii	6	7.1
Ae. vexans	3	3.6
Ae. campestris	1	1.2
Ae. flavescens	1	1.2

Figure 3. Mosquito species rank abundance and percent rank from the Lake Mason trapping site during field season 2013. Specimes were collected prior to the NRCS CIG award; however, resources were used to process these and contribute them to the Montana Mosquito Survaleance Program.

Our team did add one new, and previously non-trapped location from Richland County during field seasons 2015 (Fig. 4) and 2016 (Fig. 5). *Aedes vexans* was the most abundant species collected at this trapping location in both 2015 (Fig. 4) and 2016 (Fig. 5). During both years, *Culex tarsalis*, a main vector of West Nile virus, was the third most abundant mosquito and was collected at 9.6% (76 specimens) during 2015 and 13.0% (71 specimens) during 2016.

County: Richland

Site: Sidney

Year: 2015, 7 Trap Nights

Species	Total Counted	%
Ae. vexans	483	60.9
Ae. trivittatus	200	25.2
Cx. tarsalis	76	9.6
An. earlei	17	2.1
Ae. dorsalis	8	1.0
Ae. hendersoni	6	0.8
Ae. increpitus	2	0.3
Cq. perturbans	1	0.1

County: Richland

Year: 2016, 5 Trap Nights

Species	Total Count	%
Ae. vexans	282	51.7
Ae. trivittatus	181	33.2
Cx. tarsalis	71	13.0
Ae. dorsalis	5	0.9
An. earlei	2	0.4
Ae. s. spencerii	2	0.4
Cs. inornata	1	0.2
Ae. melanimon	1	0.2

Figure 4 (left) and Figure 5 (right) of Mosquito species rank abundance and percent rank from the Sidney trapping sites during field season 2015 and 2016. Specimens were collected as part of the NRCS CIG award mapping the diversity and distribution of West Nile virus vectors across grouse habitats and were contributee to the Montana Mosquito Survaleance Program.

4) Objective: Build and demonstrate habitat monitoring tools which quantify improvements using the end goal of encouraging adoption of adapting conservation management and incentive systems.

Deliverable: Select pollinators taxa serve as food items of sage-grouse. To address habitat monitoring tools associated with pollinators and sage-grouse food, we built a linear regression model representing relative pollinator abundance as a function of percent bare ground (Fig. 6). Pollinator abundance is negatively correlated with floral resources because as floral resources increase, the numbers of pollinators caught by traps decreases. Our work is attempting to put arthropod abundances in sage-brush steppe habitats in context with the level of bare ground. Rest-rotation livestock grazing programs aim at increasing plant diversity.

Figure 6 addresses this initial relationship by identifying our research locations as a function bare ground or inverse visibility, which are associated with livestock grazed and deferred areas. Rest-rotation grazing programs in xeric sagebrush steppe habitats are designed to increase plance diversity and in areas of over-grazing, fill in ground-level bare space with diversity flowering forbs which are essential for native rangeland pollinator survival.

The linear regression generated from our data suggests that: **Pollinator Catch = 47.969 + 59.765 * bareground** with the following descriptive statistics and Statistical Tests. With more data generated in years to come, we can continue to accurize this equation for rangeland habitat monitoring.

DESCRIPTIVE STATISTICS:	STATISTICAL TESTS:
$R^2 = 0.156$	PRESS = 64042.592
$F = 4.244$	NORMALITY TEST: FAILED (P = 0.0049); W STATISTIC = 0.8729
DF = 1,24	CONSTANT VARIANCE TEST: PASSED (P = 0.4124)
$P = 0.05$	SIGNIFICANCE LEVEL = 0.05

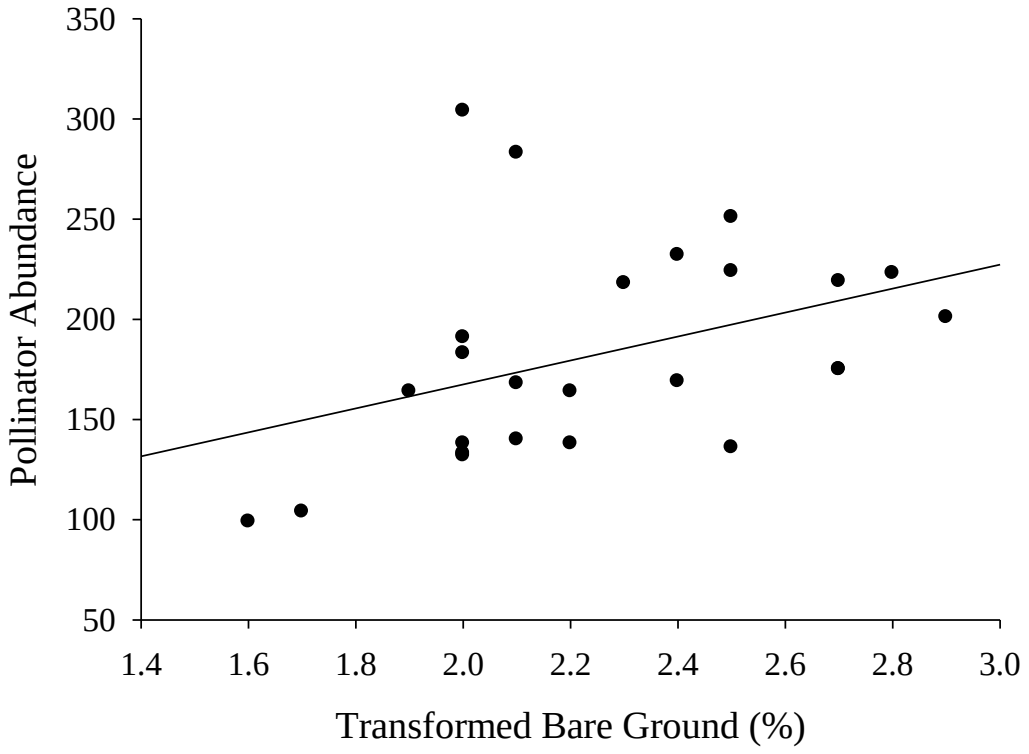

Figure 6. Relative pollinator abundance as a function of the percentage of bare ground at each trapping location. Pollinator catches are often negatively correlated with increasing floral abundance. With an increase in bare ground, floral resources decrease so that catches in pollinator traps are higher, due to the limited floral resource. The opposite is true with a decrease in bare ground. Rest-rotational grazing programs are documented at increasing plant diversity.

Lepidoptera (Butterfly and Moth) larvae serve as food items for sage-grouses chicks. Our collections indicate that these food items are approximately 6.2% of all pollinating arthropods present in our study area (Table 1). Native bees (Hymenoptera) represent the largest group of arthropod pollinators on native rangelands across the western US. Collections of the Family Halictidae (Sweat Bees) dominated our native bee collections at 76.9% followed by Apidae (Bumble Bees) at 7.7% (Table 1). Bees in the Families Megachilidae and Andrenidae followed at 3.6 and 3.4% respectively. Syrphidae (Syrphid Flies) are not bees but flies, as their name suggests, and were 1.7% of the total catch. The final Family collected from our study site was Colletidae at 0.5%.

Our study location is composed of primarily native sagebrush steppe rangeland. During our trapping efforts, we did not collect any non-native honey bees. Ecologically, this is beneficial to native bee populations from the aspect of competition for floral resources and disease/ectoparasite transmission from domesticated honey bees to native bee taxa.

Table 1. Pollinator Families collected from three Insect Orders (Hymenoptera, Diptera, Lepidoptera) and the rank percentage of captures from colored pan traps located north of Lavina, MT.

Hymenoptera	Rank Percentage
Apidae	7.7
Colletidae	0.5
Andrenidae	3.4
Halictidae	76.9
Melittidae	0
Megachilidae	3.6
Diptera	
Syrphidae	1.7
Lepidoptera	
Butterflies/Moths	6.2

5) Transfer knowledge gained and tools from objectives 1 – 4 to livestock producers, public/private landowners and managers, and wildlife management agencies.

<u>During and following the granting period, oral presentations have been given at:</u>

2015

1. Sage-grouse oversight committee meeting – Helena, MT
2. NRCS SGI Landowner appreciation dinner – Roundup, MT

2016

1. Sage-grouse oversight committee meeting – Helena, MT
2. 30th Western Agencies Sage and Columbian Sharp-tailed grouse workshop – Lander, WY
3. Invited Speaker: 6th annual NRCS Sage-grouse Initiative Annual Conference – Lewistown, MT
4. Invited Speaker: NRCS Shifting to Soil Biology Agronomy and Range Tour – Baker, MT
5. Invited Speaker: NRCS Bowman-Slope Conservation District: Grazing and Wildlife Workshop – Rhame, ND

2017

1. MSU Extension Service Livestock Workshop – Columbus, MT
2. Sage-grouse oversight committee meeting – Helena, MT

2018

1. Montana State University ANSC 410, senior level Veterinary Entomology Course. Instructor: Dr. Hayes Goosey, Award PI. One 75-minute class presentation.
2. Montana Nutrition Conference (Poster Display) – Bozeman, MT
3. Montana Range Forum – Billings, MT
4. Voice of Montana Farmers Workshop – Bozeman, MT
5. 31st Western Agencies Sage and Columbian Sharp-tailed grouse workshop – Billings, MT

We are assembling two peer-reviewed publications to be submitted in September 2018 and again in June 2019. The New Technology and Innovative Approach Fact Sheet will be generated from these two peer reviewed publications.