Environment and Natural Resources Trust Fund (ENRTF)
M.L. 2018 ENRTF Work Plan (Main Document)

Today's Date: December 15, 2017

Date of Next Status Update Report:

Date of Work Plan Approval:

Project Completion Date: June 30, 2020

Does this submission include an amendment request? __no

PROJECT TITLE: Develop a System to Assess Wildlife Health Threats in Minnesota

Project Manager: Kimberly VanderWaal

Organization: University of Minnesota

College/Department/Division: Department of Veterinary Population Medicine

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Location: Statewide

Total Project Budget: $280,000

Amount Spent: $0

Balance: $280,000

Legal Citation: M.L. 2018, Chp. xx, Sec. xx, Subd. xx

Appropriation Language:

I. PROJECT STATEMENT:

We propose to advance ***surveillance for wildlife health threats within Minnesota through the development of information management and analytical systems that utilize wildlife rehabilitation data.*** Threats to animal health include toxins and diseases such as avian influenza, West Nile Virus, and canine distemper. Lack of information on the occurrence of these threats in wildlife makes it challenging to identify concerning trends in wildlife population health, but sampling free-ranging wildlife is expensive, challenging, and time-consuming. In contrast, over 13,000 animals are admitted annually to wildlife rehabilitators in Minnesota. Health information routinely recorded on these animals (e.g., species, age, location, reason for admission, and symptoms/clinical signs) could be utilized for tracking health trends. However, we lack systems to aggregate and analyze these data and thus wildlife rehabilitation data is currently a missed opportunity. This project will develop information systems to monitor wildlife health in Minnesota and provide an early warning system with the potential to detect new health threats or emerging environmental issues impacting health. This monitoring system may also identify geographic areas or species experiencing health events, which will allow for more strategic use of resources in that these populations can be targeted for more in-depth health investigations or interventions, leading ultimately to more effective control and prevention of emerging health threats.

Our specific aims are to:
1) Establish data systems that utilize wildlife rehabilitation data to monitor wildlife population health trends
2) Develop an alert system for detecting anomalies in wildlife rehabilitation data that may indicate emerging health threats
3) Investigate environmental and land-use drivers of wildlife health trends

The Raptor Center (TRC) and Wildlife Rehabilitation Center of Minnesota (WRC) have maintained electronic medical databases on rehabilitated animals since 1990 and 1999, respectively. These animals can be used as sentinels for underlying health issues in wild populations, for detecting emerging health threats, and for monitoring the relative abundance of species across time. To maximize the utility of data, TRC, WRC, and others developed a standardized terminology for health records at wildlife care centers as part of a previous ENRTF project. These standards facilitate the integration and analysis of medical records from different wildlife rehabilitators for surveillance purposes. As a proof-of-concept, analysis of TRC rehabilitation data shows that we could have detected the arrival of West Nile Virus in Minnesota in 2002. However, for effective and timely surveillance, we urgently need systems to monitor these data in real-time rather than analyzing the data after the event has occurred. This project will enhance our ability to understand drivers of health in wildlife populations and to conduct surveillance for emerging health threats.

II. OVERALL PROJECT STATUS UPDATES:

First Update January 31, 2019

Second Update June 30, 2019

Third Update January 31, 2020

Final Update June 30, 2020

III. PROJECT ACTIVITIES AND OUTCOMES:

ACTIVITY 1: ***Establish data systems utilizing rehabilitation data to monitor wildlife health***
Description:

We will build a central database for MN wildlife rehabilitation data. Aggregated data will include retrospective data from the 1990s to present as well as prospective data on animals admitted for rehabilitation. Data will be used to a) quantify seasonal patterns of wildlife admissions based on species, age, and clinical signs, and b) evaluate long-term trends in wildlife rehabilitation data. Results will be used to establish baselines of what are "typical" patterns of admission. We will c) build an online platform to facilitate data aggregation across facilities, data analysis, visualization, and reporting of health trends to allow easy access and use by different stakeholders (e.g. veterinarians, researchers, policy makers).

Briefly, data from the past 15 years will be compiled from TRC and WRC to assemble a single database including the date of admission, species, clinical signs, and location. A retrospective summary of the weekly admission data will be compiled using the vetsyn package in R Statistical Software. Retrospective patterns will be further analyzed using univariate and multivariate time-series analyses. These time series models allow for the establishment of baseline patterns of wildlife admission data, accounting for long-term trends and seasonal variation.

The online data aggregation platform will be constructed for data visualization and analysis. We will work with IT professionals at both WRC and TRC in order to connect their databases to the central database accessed by the data platform.

ENRTF BUDGET: $120,300

Outcome	Completion Date
a. Quantify seasonal patterns of wildlife admission data	30 DEC 2018
b. Establish baselines and evaluate long-term wildlife health trends	30 DEC 2018
c. Build online platform for data aggregation, analysis, and reporting	30Jun 2020

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Activity 2: ***Develop an alert system for detecting anomalies in wildlife rehabilitation data that may indicate an emerging health threat***

Using time series analysis of retrospective data, we will **a)** forecast expected patterns based on seasonal and long-term trends. We will then, **b)** develop analytical pipelines to detect aberrations in the data that deviate from forecasted patterns that may indicate a new or changing health threat (such as a new disease). We will also apply spatial tools to **c)** identify spatial and temporal clusters of cases that may indicate a health event is occurring. Alerts will be issued when data anomalies or case clusters are detected. Validation of alert system will focus on optimizing the sensitivity of the system to detect health concerns while minimizing "false alarms."

Once robust baselines are developed with retrospective data, expected patterns can be forecasted for each syndrome. These forecasts represent the expected or typical patterns in the data, and anomalies can be detected based on deviations from forecasted patterns. In order to optimize and validate the anomaly detection algorithms, we utilize a number of true and simulated health events to train the algorithms using the retrospective data. We do this in order to be able to compare the accuracy of the detection algorithms against a

known health-related data anomaly, such as the emergence of West Nile Virus in birds. Anomaly detection algorithms to be explored and optimized include Holt-Winters and Shewart control charts, cumulative sums (CUSUM) charts, exponential weighted moving averages, and support vector machines. The threshold value for generating an alert (i.e., the magnitude in which the observed data deviates for the expected pattern) will be optimized to maximize sensitivity of the early warning system while minimizing the risk of false alarms.

In addition, tools for detection of clusters cases in time and space will be applied to identify and quantify epidemiological patterns. Cases that cluster in time, space, or both are potentially epidemiologically linked, either representing potential transmission events in the population or exposure to a common set of environmental risk factors. Cluster analysis techniques will include k-functions, Knox tests, Mantel tests, Oden's directional test, and the scan statistic. Detection of case clusters will be used as an addition method for generating alerts about emerging or changing health issues.

ENRTF BUDGET: $105,300

Outcome	Completion Date
a. Forecast expected number of animals admitted for rehabilitation based on seasonal patterns and long-term trends	30 JUN 2019
b. Develop analytics to detect anomalies in the data that may serve as an early warning for an emerging health concern	30 DEC 2019
c. Identify spatial/temporal clusters of cases that may indicate a health event is occurring	30 DEC 2019

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Activity 3: ***Investigate environmental and land-use drivers of wildlife health***

Using Geographic Information Systems (GIS) and ecological modeling, we will a) analyze relationships between spatial patterns in health data and landscape factors, such as roads, land cover, land use, etc. We will also b) assess relationships between temporal patterns in health data and changes in climatic and weather conditions. Results from this activity will help describe drivers of health trends, and identify high-risk areas where wildlife populations may be experiencing poor health or environmental threats to their health.

Understanding the distribution and conditions associated with past animal health anomalies can help predict areas that are likely to experience similar events in the future. Such predictions can be based on environmental conditions, history of similar anomalies within an area, land use/land change, proximity to urban areas, etc. These data can be collected from available maps, GIS layers, and other databases. To determine which landscape and environmental factors are important drivers of the spatial pattern of cases in Minnesota, we will develop analytical models that can be used to identify areas most at risk for anomalies. Modeling methods include generalized linear mixed-effect modeling on the number of cases per county, kriiging, and/or ecological niche modeling using maximum entropy.

These multivariate spatial models will allow us to evaluate underlying environmental factors correlated with cases, and then identify high-risk regions with similar environmental factors that may be similarly vulnerable to a given

animal health concern. Additionally, time series regression will be used to assess the impact of climate change and intra- and inter-annual variation in weather on animal health.

ENRTF BUDGET: $54,400

Outcome	Completion Date
a. Analyze relationships between wildlife health data and landscape factors	30 JUN 2020
b. Assess relationships between temporal patterns in health data and changes in climatic and weather conditions	30 JUN 2020

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IV. DISSEMINATION:

Description:
Our findings will be shared with state and county agencies, as well as non-government organizations, for their use in preventing, assessing, and responding to animal health threats. Findings will be presented at state, regional, and national meetings (e. SETAC, TWS, EEID) as appropriate given the results. Publications will be produced for peer-reviewed journals, and outreach newsletters. Media outreach will also be pursued.

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V. PROJECT BUDGET SUMMARY:

A. Preliminary ENRTF Budget Overview: See attached budget sheet

Explanation of Capital Expenditures Greater Than $5,000: N/A

Explanation of Use of Classified Staff: N/A

Total Number of Full-time Equivalents (FTE) Directly Funded with this ENRTF Appropriation:

Enter Total Estimated Personnel Hours: 5184	Divide by 2,080 = TOTAL FTE: 2.5

Total Number of Full-time Equivalents (FTE) Estimated to Be Funded through Contracts with this ENRTF Appropriation:

Enter Total Estimated Personnel Hours: 205	Divide by 2,080 = TOTAL FTE: 0.1

B. Other Funds:

SOURCE OF AND USE OF OTHER FUNDS	Amount Proposed	Amount Spent	Status and Timeframe
Other Non-State $ To Be Applied To Project During Project Period:			
Perez -1% effort Y1 and Y2 (75% salary, 25% fringe); Ponder -1% effort Y1 and Y2 (75% salary, 25% fringe); Willette-1% effort Y1 and Y2 (75% salary, 25% fringe)	$ 10,338	$ 0	Planned over two years of grant.
Other State $ To Be Applied To Project During Project Period:			
NA	$	$	
Past and Current ENRTF Appropriation:			
In 2008, a 2 year grant received by the University of Minnesota funded the development of the standardized terminology for clinical wildlife medicine that makes this project possible	$ 100,000	$ 100,000	Completed grant
Other Funding History:			
NA	$	$	

VI. PROJECT PARTNERS:

A. Partners receiving ENRTF funding

Name	Title	Affiliation	Role
Kimberly VanderWaal	Assistant Professor	University of Minnesota (UMN)	Project manager

B. Partners NOT receiving ENRTF funding

Name	Title	Affiliation	Role
Julia Ponder	Director of TRC, Assistant Professor	The Raptor Center UMN	Avian and conservation medicine
Michelle Willette	Staff veterinarian	The Raptor Center UMN	Avian and conservation medicine
Philip Jenni	Director, WRC	MN Wildlife Rehabilitation Center	Wildlife medicine
Renee Schott	Staff veterinarian, WRC	MN Wildlife Rehabilitation Center	Wildlife Medicine
Andres Perez	Associate Professor	UMN	Epidemiological methods

Petra Muellner	Director	Epi-Interactive	Advisor on surveillance and information systems

VII. LONG-TERM- IMPLEMENTATION AND FUNDING:

Monitoring of wildlife health in free-ranging animals is costly and time-consuming. In contrast, rehabilitation data is already available and will continue to be routinely collected, though it is not currently used to systematically monitor health. Our online platform will ensure long-term sustainability of this initiative, given that data aggregation, analysis, and alerts will be automated through analytical pipelines within the system. In the future, the system can easily be scaled to surrounding states to gain additional insights about potential health threats to Minnesota wildlife. The system will also be widely accessible to health and natural resources agencies, including the MN DNR and Board of Animal Health, for management of natural resources and disease surveillance. Our monitoring and alert system will also assist wildlife managers and decision makers in targeting follow-up animal health investigations and interventions, leading to more strategic use of resources for sampling wildlife populations and ultimately improve our ability to monitor and manage the health of Minnesota wildlife.

VIII. REPORTING REQUIREMENTS:

- **The project is for 2 years, will begin on July/1/2018, and end on June/30/2020**
- **Periodic project status update reports will be submitted 1/1 and 6/1 of each year.**
- **A final report and associated products will be submitted between June 30 and August 15, 2020.**

IX. SEE ADDITIONAL WORK PLAN COMPONENTS:

A. Budget Spreadsheet - attached

B. Visual Component or Map - attached

C. Parcel List Spreadsheet N/A
D. Acquisition, Easements, and Restoration Requirements N/A
E. Research Addendum Submitted, reviewed and updated

Attachment A:
Environment and Natural Resources Trust Fund
M.L. 2018 Budget Spreadsheet

Project Title: Develop a System to Assess Wildlife Health Threats in Minnesota
Legal Citation:
Project Manager: Kimberly VanderWaal
Organization: University of Minnesota
College/Department/Division: Department of Veterinary Population Medicine
M.L. 2018 ENRTF Appropriation: $280,000
Project Length and Completion Date: 2 years; June, 30 2020
Date of Report: February 19, 2018

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET	Budget	Amount Spent	Activity 1 Balance
BUDGET ITEM			
Personnel (Wages and Benefits)	$170,056	$0	$170,056
TBD: Post-doc/grad student - 1 FTE, 2 yrs, total: $116,425 (82%-salary, 18% benefits)			
VanderWaal: Project manager - 15% FTE, 2 yrs, total: $45,305(75% salary, 25% fringe)			
TBD: TRC technician - 200hours each Y1 and Y2, total: $8,327 (78% salary, 21% fringe)			
Professional/Technical/Service Contracts	$107,600	$0	$107,600
A consultant (Company: Epi-Interactive) will be paid to develop the on-line platform and tools required for the surveillance and alert systems. $83,000			
The Wildlife Rehabilitation Center- Professional/technical service contaract (205 hours@120/hr).Total $24,600			
Equipment/Tools/Supplies	$544	$0	$544
Office supplies and incidentals			
Travel expenses in Minnesota	$1,800	$0	$1,800
Travel within MN to for meetings with wildlife health professionals$1,800 per U of M reimbursement plan			
COLUMN TOTAL	$280,000	$0	$280,000

Early warning information system for monitoring wildlife health

Animals admitted for rehabilitation

Wildlife Rehabilitation Center of Minnesota

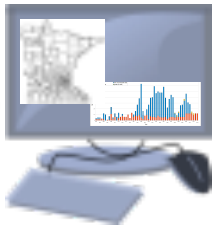
University of Minnesota
The Raptor Center

Wildlife Health Database

Visualize & Analyze

Detect data anomalies: potential new health threat

Interpret & Report



Alert

Alert system identifies wildlife population health concerns that are atypical and need follow-up investigation / intervention

Case study: Detecting the arrival of West Nile Virus in MN using rehabilitation data