



SOP4CWD

Improving CWD Surveillance Through "Big Data" Infrastructure

Presented by:

Brenda Hanley, PhD

brought to you by:

Cornell Wildlife Health Lab

a New York State Wildlife Health Program partner



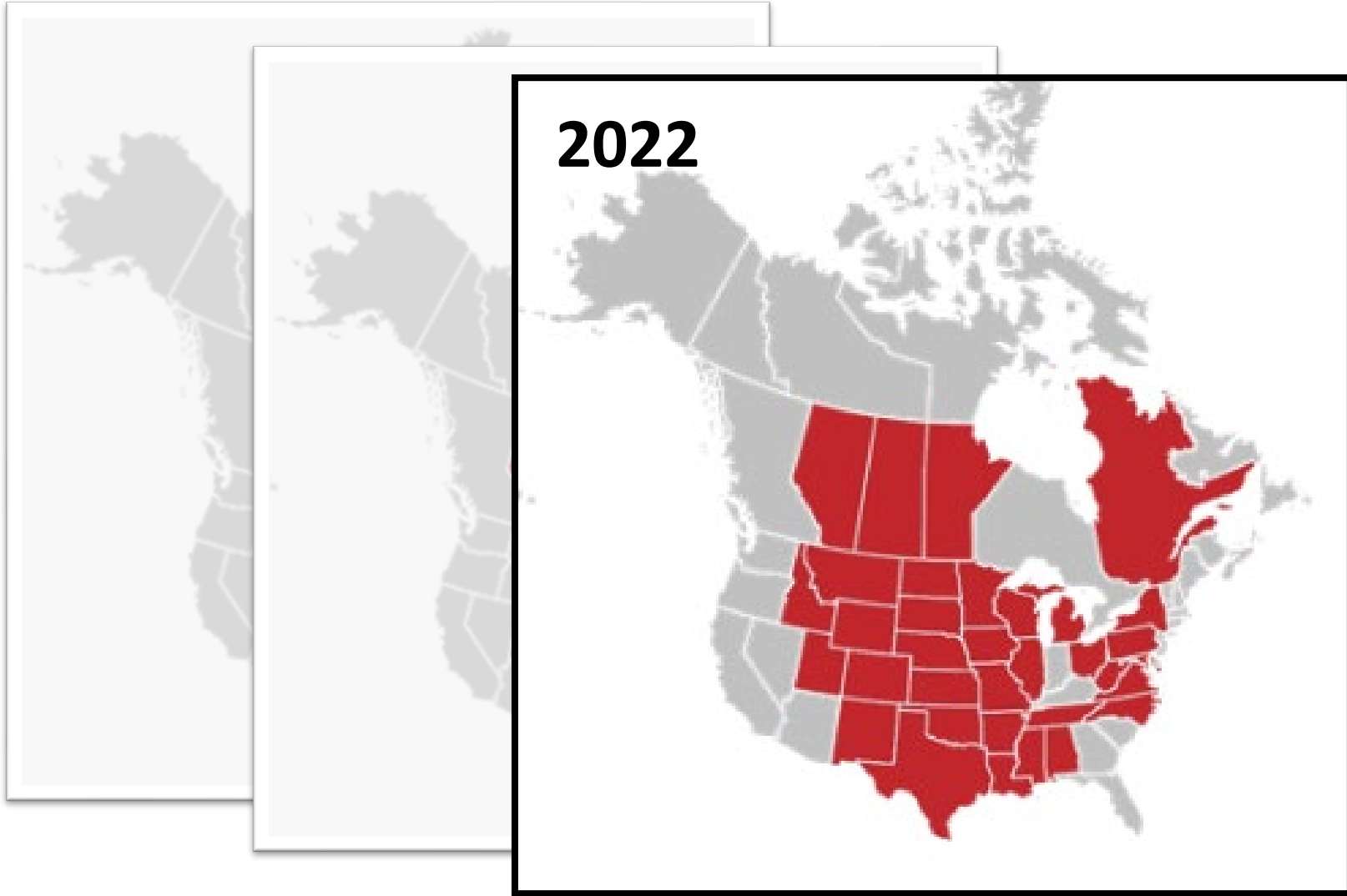
Cornell University
College of Veterinary Medicine
Animal Health Diagnostic Center



Growing Distribution of CWD



Growing Distribution of CWD



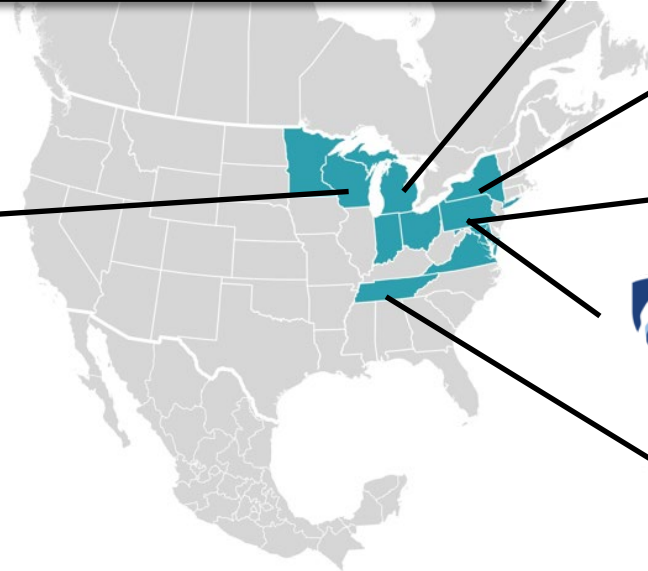
The Early Days of SOP4CWD (2020)



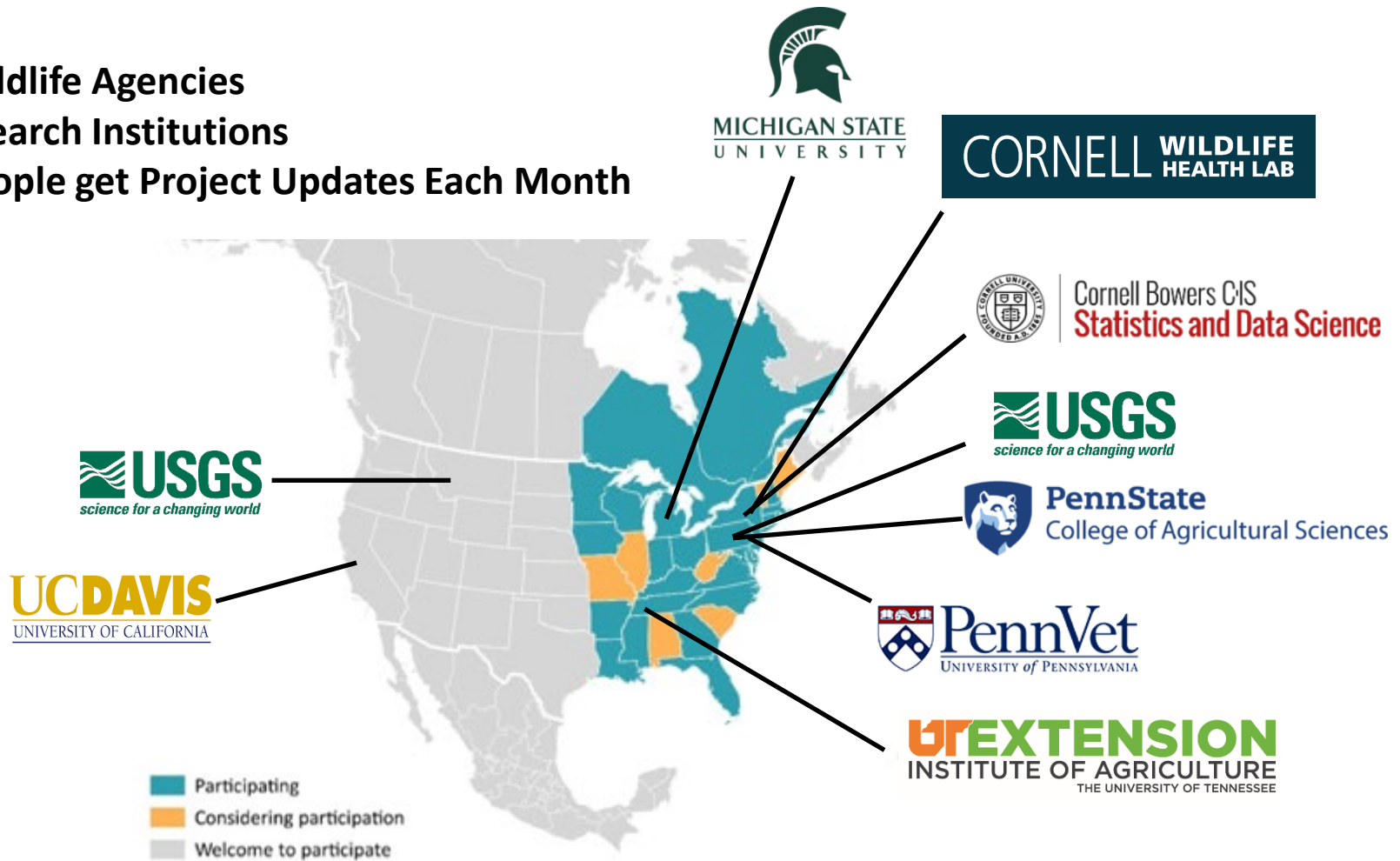
CORNELL WILDLIFE HEALTH LAB



 Participating



- ➔ 26 Wildlife Agencies
- ➔ 7 Research Institutions
- ➔ 99 People get Project Updates Each Month



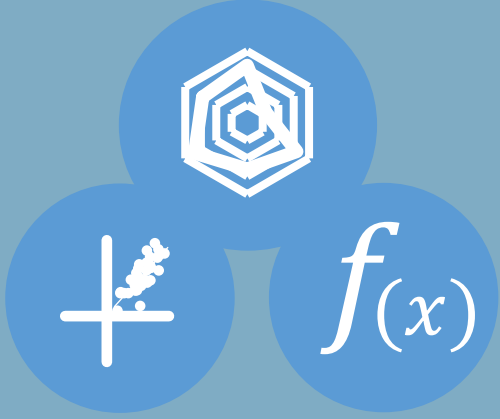


Organizational Infrastructure


Agency Participation



The Warehouse



Current Models and Outputs



Pending Models

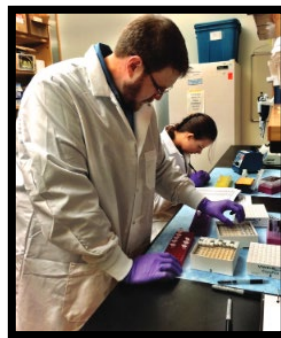


The Future

SOP4CWD Project: Data Use Agreement

**CORNELL WILDLIFE
HEALTH LAB**

This Data Use Agreement ("Agreement") is entered into as of _____ (MM/DD/YYYY; "Effective Date"), between Cornell University, a non-profit, educational institution with corporate powers under the laws of the State of New York, having an office at 373 Pine Tree Road Ithaca, NY 14850 (hereinafter called "Cornell"), and _____ (State Agency Name, hereinafter called "Provider"), having an office at _____ (State Agency Address).



Species	Age	Sex	Date	Tissue	Source
white-tail	Yearling	Female	11/8/2020	Lymph	No Hunter harvest
white-tail	Adult	Male	11/7/2020	Lymph	No Hunter harvest
white-tail	Adult	Male	11/7/2020	Lymph	No Hunter harvest
white-tail	Yearling	Male	11/7/2020	Lymph	No Hunter harvest
white-tail	Adult	Male	11/7/2020	Lymph	No Hunter harvest
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white-tail	Adult	Female	11/8/2020	Lymph	No Hunter harvest
white-tail	Adult	Male	11/7/2020	Lymph	No Hunter harvest
white-tail	Adult	Male	11/3/2020	Lymph	No Hunter harvest
white-tail	Fawn	Female	11/8/2020	Lymph	No Hunter harvest
white-tail	Yearling	Male	11/7/2020	Lymph	No Hunter harvest
white-tail	Yearling	Male	11/7/2020	Lymph	No Hunter harvest
white-tail	Yearling	Female	11/7/2020	Lymph	No Hunter harvest
white-tail	Yearling	Female	11/7/2020	Lymph	No Hunter harvest





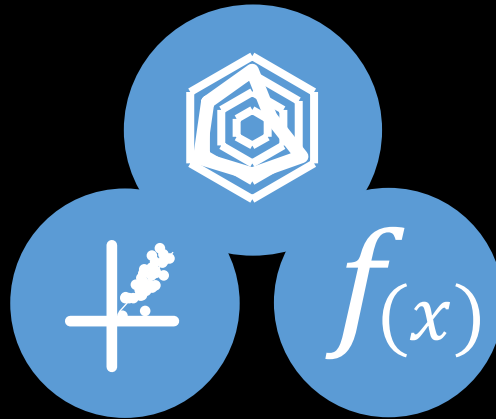
Organizational Infrastructure



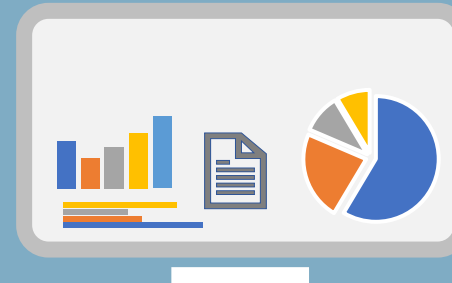
Agency
Participation



The Warehouse



Current Models
and Outputs

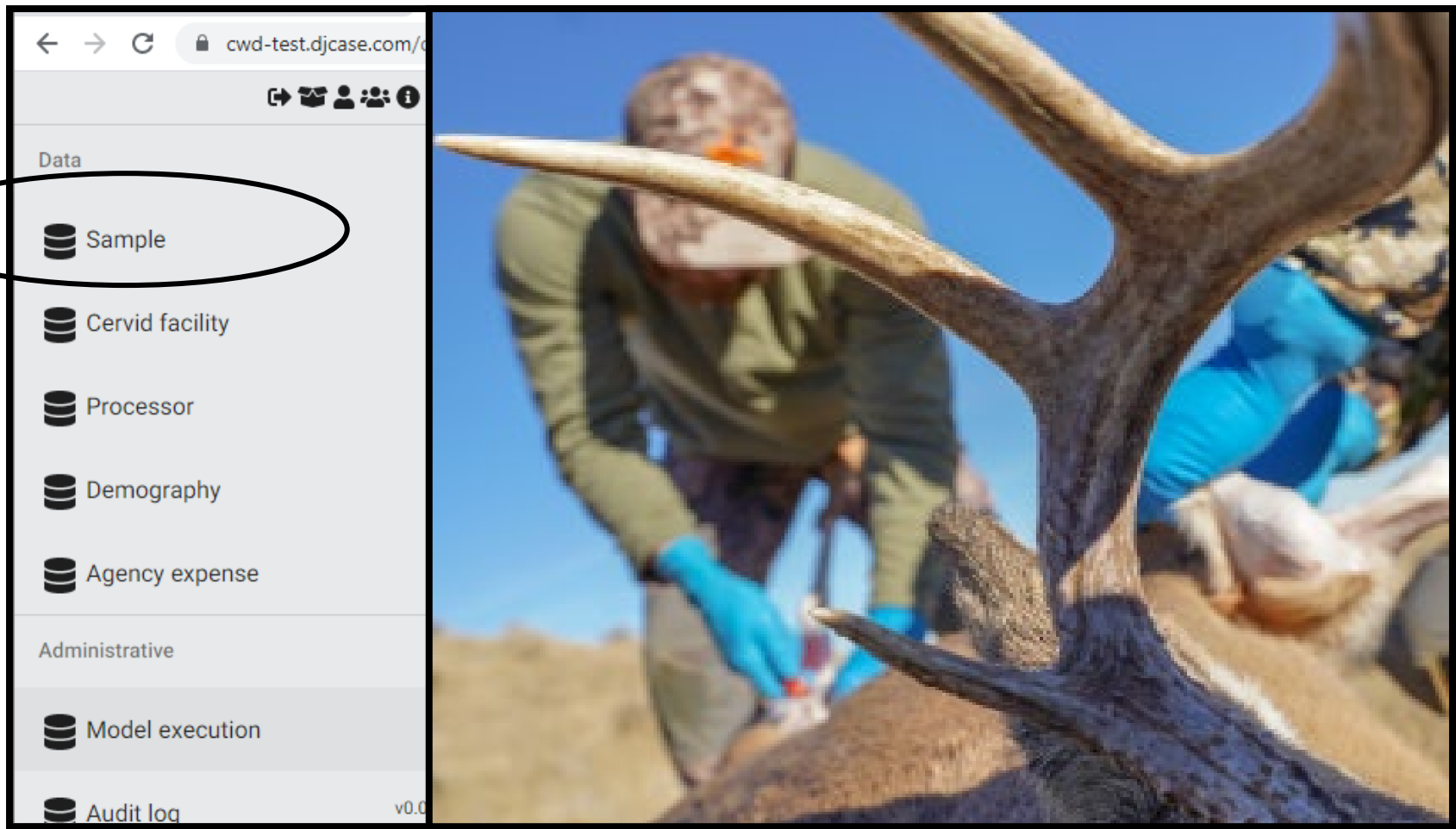


Pending
Models



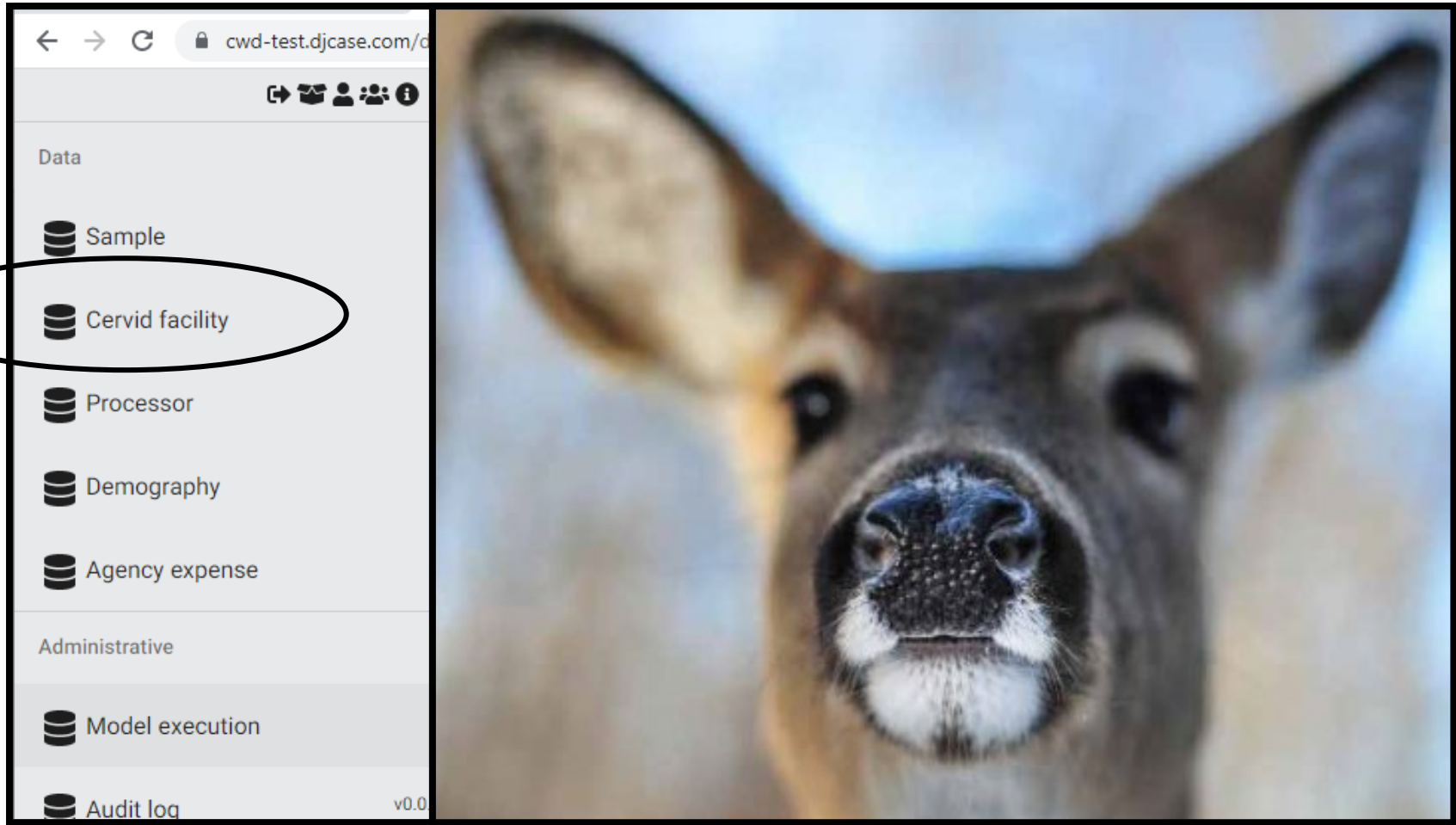
The Future

The CWD Warehouse

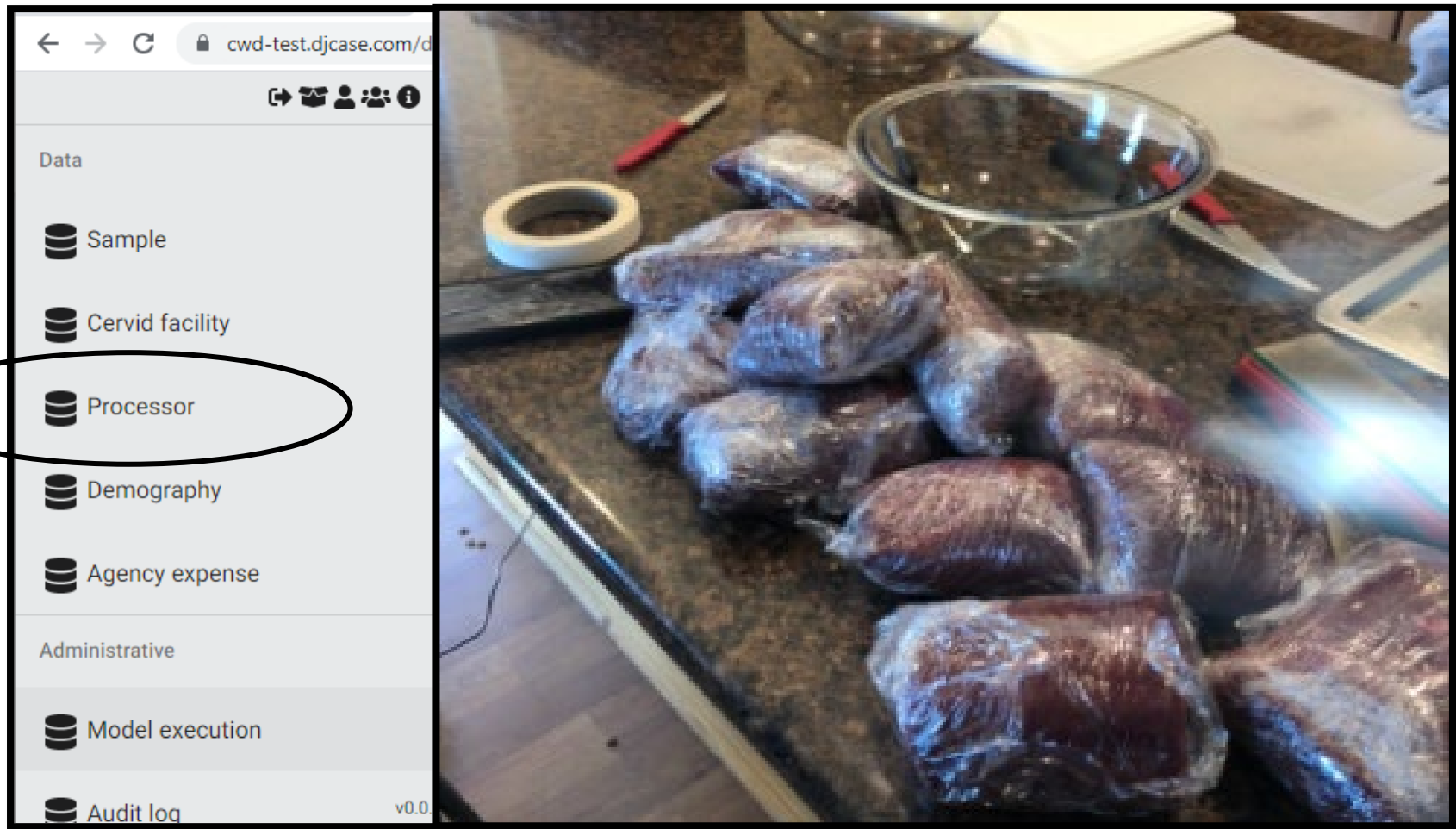


The image is a composite of two parts. On the left is a screenshot of a web browser showing a navigation menu for a system named 'CWD Warehouse'. The browser's address bar displays 'cwd-test.djcase.com/'. The navigation menu is organized into two main sections: 'Data' and 'Administrative'. Under the 'Data' section, there are six menu items, each represented by a database cylinder icon: 'Sample', 'Cervid facility', 'Processor', 'Demography', 'Agency expense', and 'Audit log'. The 'Sample' item is circled in black. Under the 'Administrative' section, there are two menu items: 'Model execution' and 'Audit log'. The right side of the image is a photograph showing a person in a green long-sleeved shirt and blue gloves working on a large set of deer antlers. The person is using a tool to cut or trim the antlers. The background is a clear blue sky and a field.

The CWD Warehouse



The CWD Warehouse



The CWD Warehouse

The screenshot shows a web browser window with the URL `cwd-test.djcase.com/d`. The navigation menu on the left is organized into sections:

- Data**
 - Sample
 - Cervid facility
 - Processor
 - Demography** (highlighted with a black oval)
 - Agency expense
- Administrative**
 - Model execution
 - Audit log

The version number `v0.0.` is visible at the bottom right of the menu. The background image shows a herd of elk grazing on a rocky, grassy hillside with forested mountains in the distance.

The CWD Warehouse

The image is a composite of two parts. On the left is a screenshot of a web browser displaying a menu for 'cwd-test.djcase.com/'. The menu is organized into sections: 'Data' (Sample, Cervid facility, Processor, Demography, Agency expense), 'Administrative' (Model execution, Audit log), and 'v0.0'. The 'Agency expense' item is circled in black. On the right is a photograph of a forest ranger in a green uniform standing next to a red truck. The truck has 'FOREST RANGER' written on its side. A large map is taped to the truck's side, showing a grid with colored markers and labels for 'Division B' and 'Division C'. Handwritten notes on a whiteboard behind the map include 'da', '2°', '3 mph', '50°', '7 mph', and '- High 50's 20's'. Other people in green uniforms are visible in the background.

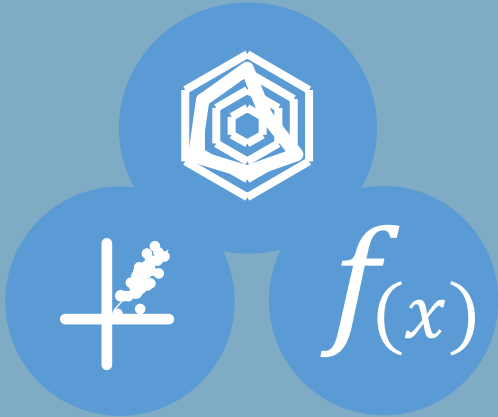


Organizational Infrastructure


Agency Participation



The Warehouse



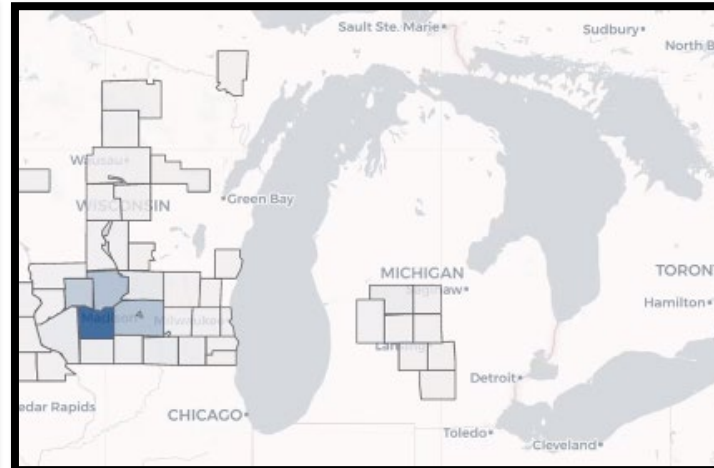
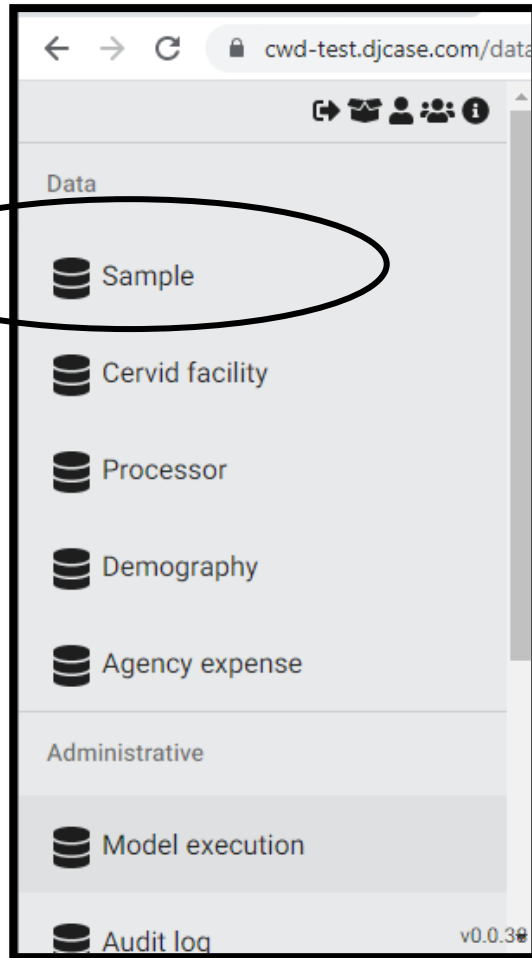
Current Models and Outputs



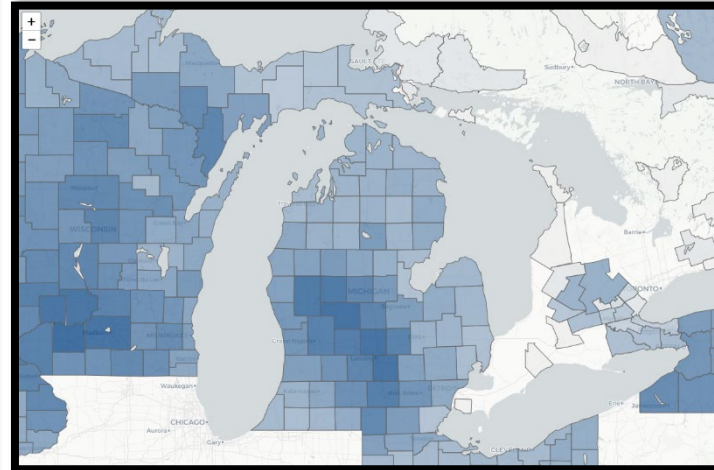
Pending Models



The Future



Confirmed CWD+ Cases



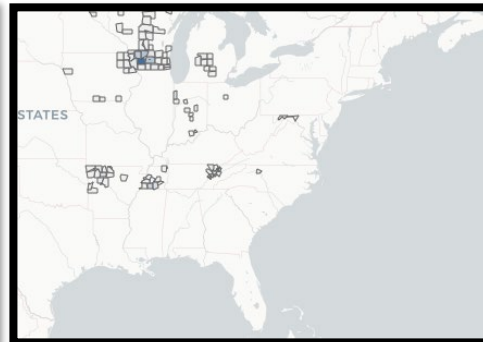
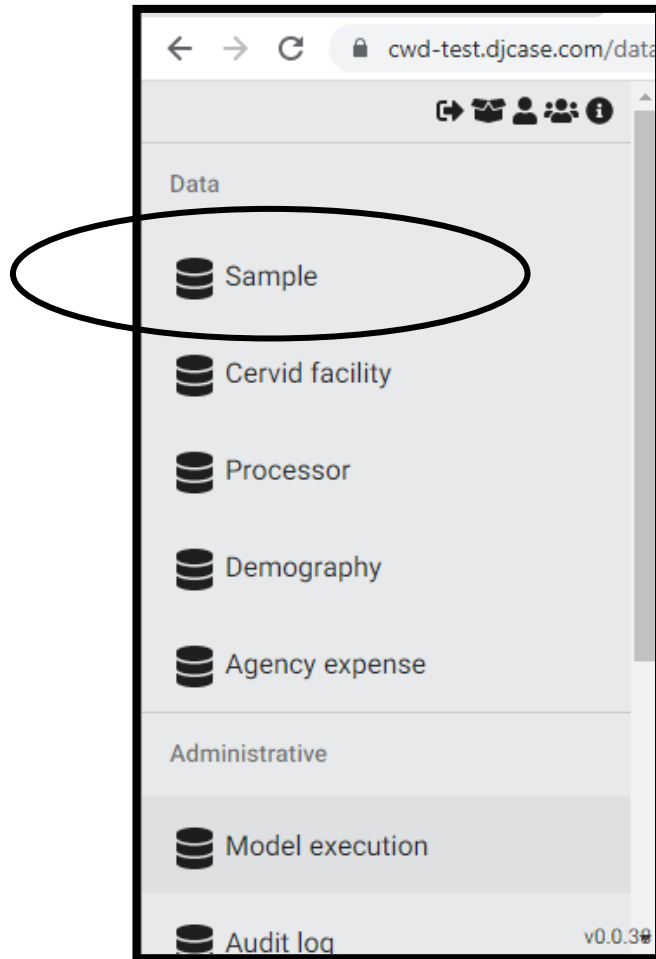
Sampling Intensity

Maps contain only the data currently shared with the project.

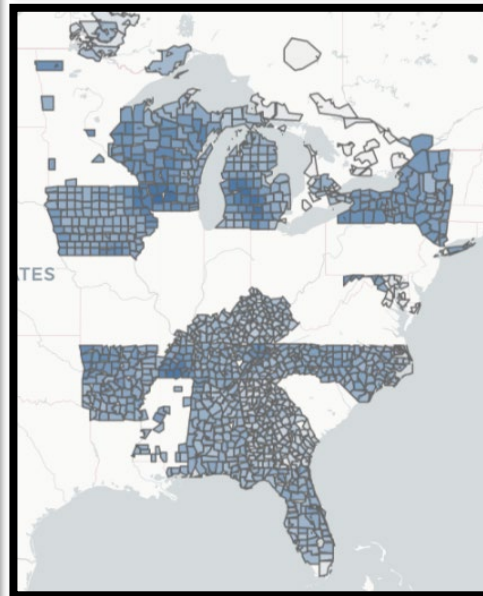
Maps are for the illustrative purpose of this presentation and should not be used, copied, or distributed.

Adapted in the Warehouse from:

Mitchell et al. 2021. Regional Wildlife Disease Positives Software. Cornell University Library eCommons Repository. DOI: 10.7298/mchw-3e31.



Confirmed CWD+ Cases



Sampling Intensity

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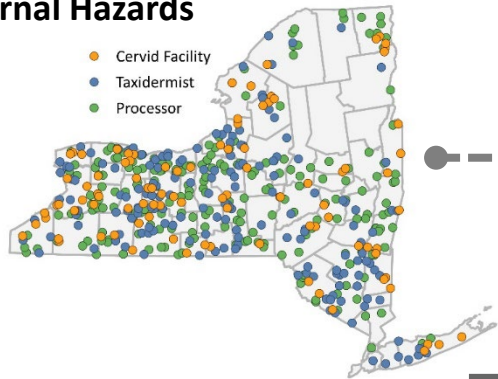
Adapted in the Warehouse from:

Mitchell et al. 2021. Regional Wildlife Disease Positives Software. Cornell University Library eCommons Repository. DOI: 10.7298/mchw-3e31.

The screenshot shows a web browser window at the URL `cwd-test.djcase.com/data/model_execution`. The page title is "Model execution". On the left sidebar, under the "Data" section, there are several menu items: Sample, Cervid facility, Processor, Demography, Agency expense, and Model execution. The "Model execution" item is circled in black. The main content area displays a table with the following columns: Model id, Reference name, Date executed, Applicable season year, State, and Output. The table contains three rows: "Hazard", "SEI", and "SEI". The "Hazard" row is circled in black. The "State" column for all rows is "Complete", and the "Output" column for all rows is "Results". At the bottom of the table, there is a pagination control showing "Items per page: 10" and "1 - 3 of 3".

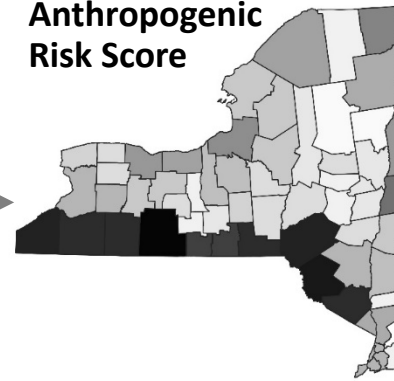
Model id	Reference name	Date executed	Applicable season year	State	Output
Hazard				Complete	Results
SEI				Complete	Results
SEI				Complete	Results

Internal Hazards



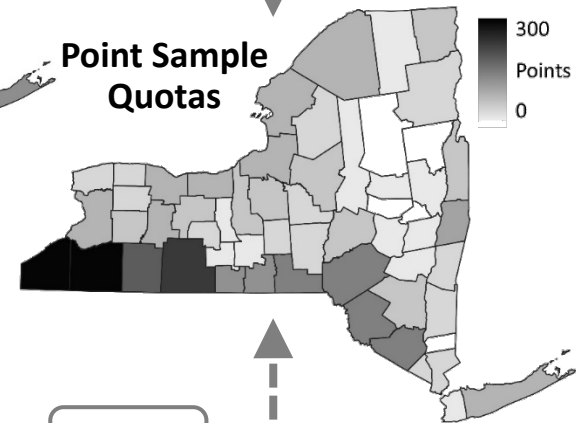
w

Anthropogenic Risk Score



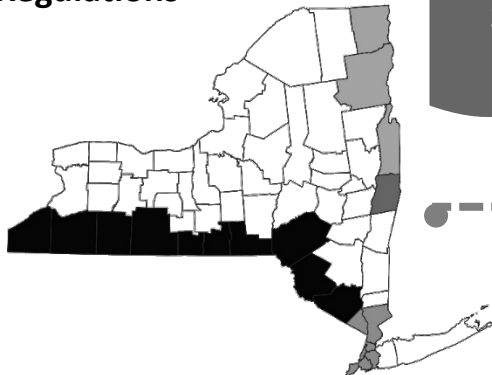
x

Point Sample Quotas



300
Points
0

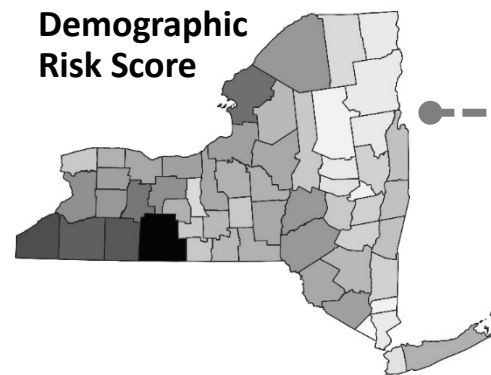
Adjacent State Conditions & Regulations



RISK
ASSESSMENT
SURVEY

w

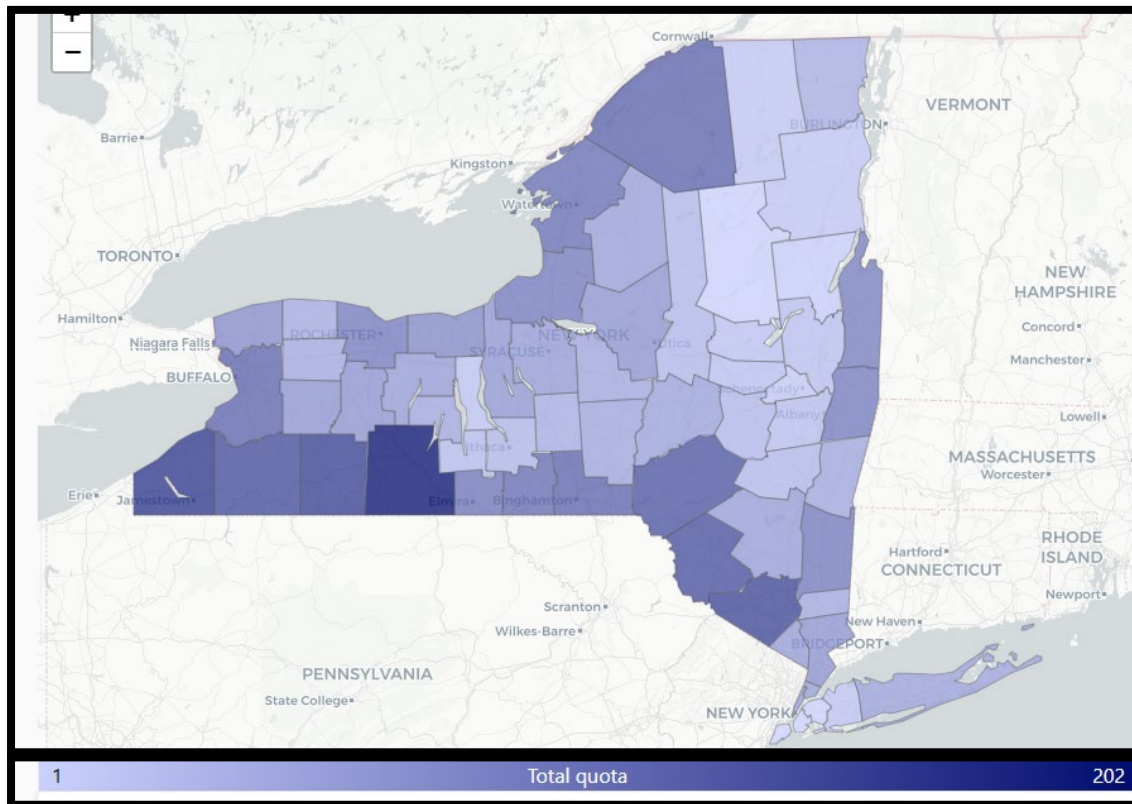
Demographic Risk Score



x

Schuler et al. Novel Detection of Chronic Wasting Disease Using Risk-Weighted Surveillance: A Tale of Two States. In Preparation.

Given the data in the Warehouse, the hazard model suggests locations for intensive sampling.



Given data uploaded into the Warehouse from the states, this model will run immediately.

Maps are for the illustrative purpose of this presentation and should not be used, copied, or distributed.

Adapted in the Warehouse from:

Hanley et al. 2021. Wildlife Disease Hazard Software. Cornell University Library eCommons Repository. DOI: 10.7298/w4rn-xq85.



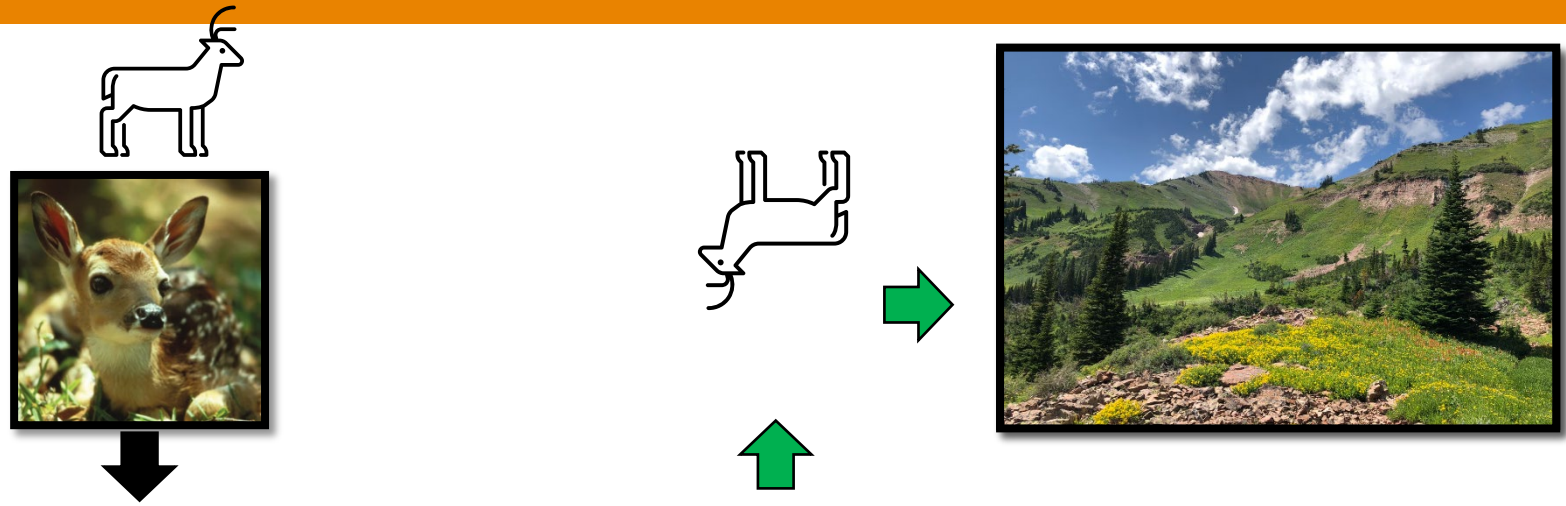
The Susceptible-Latent-Exposed-Infective (SLEI) Model



Live Cervid Population

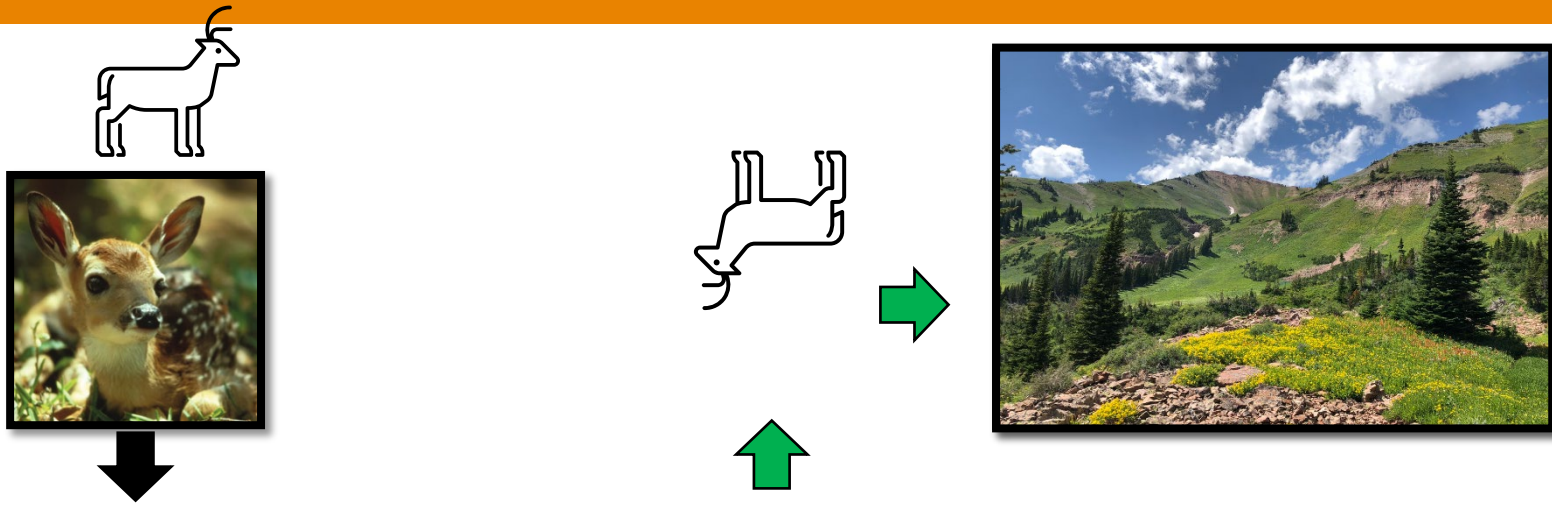


SLEI Model



Live Cervid Population

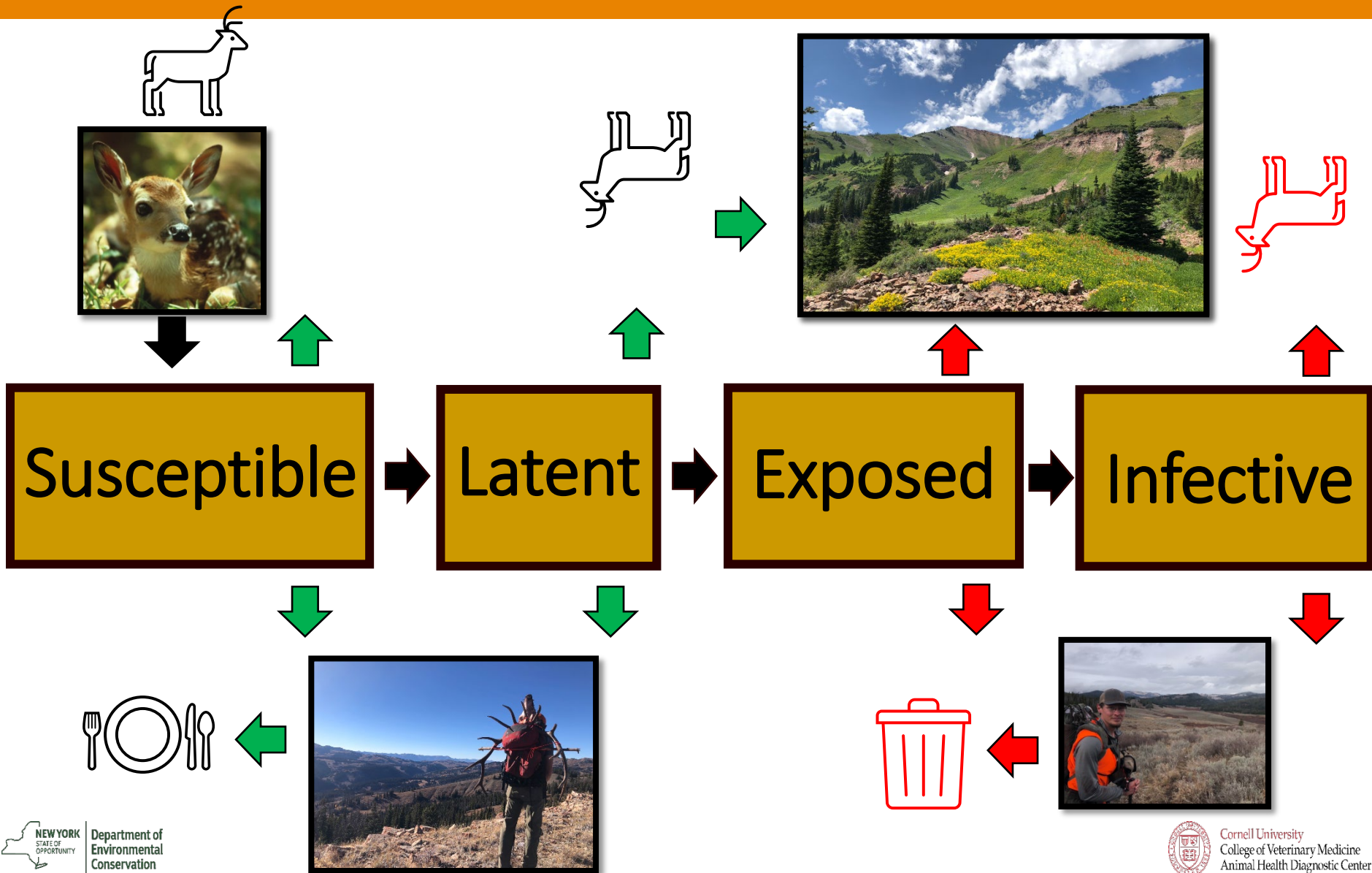
SLEI Model



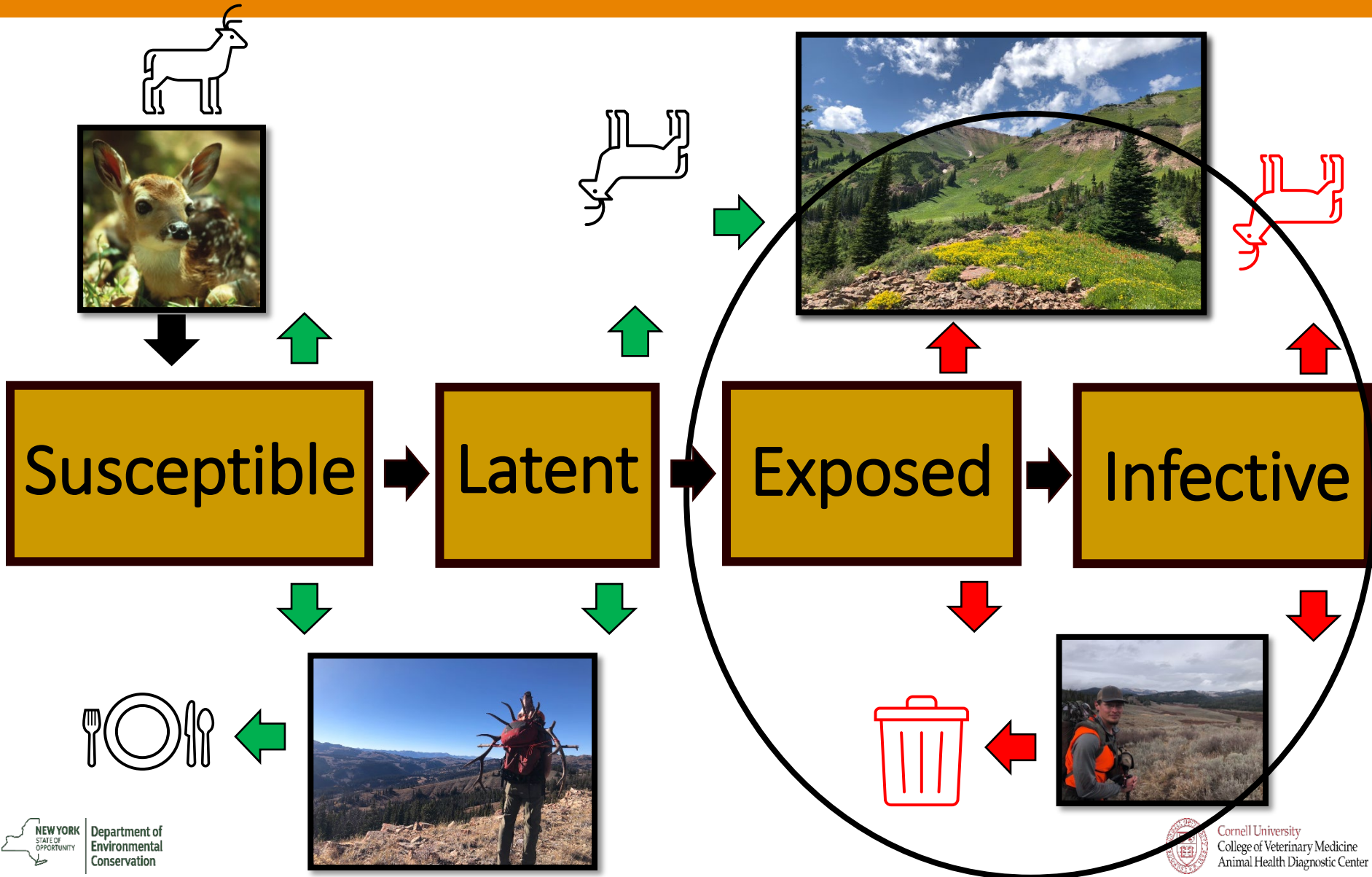
Live Cervid Population

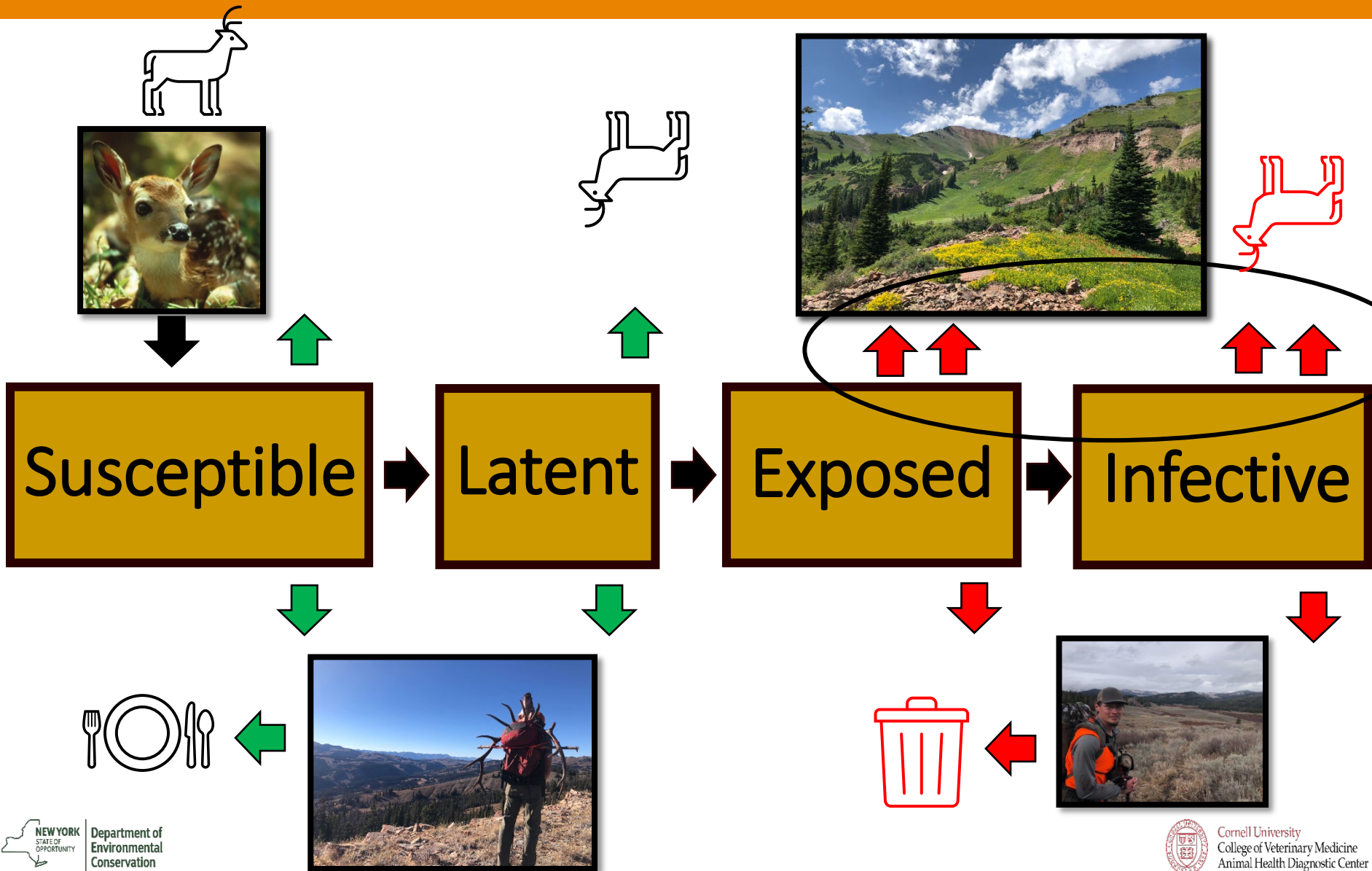


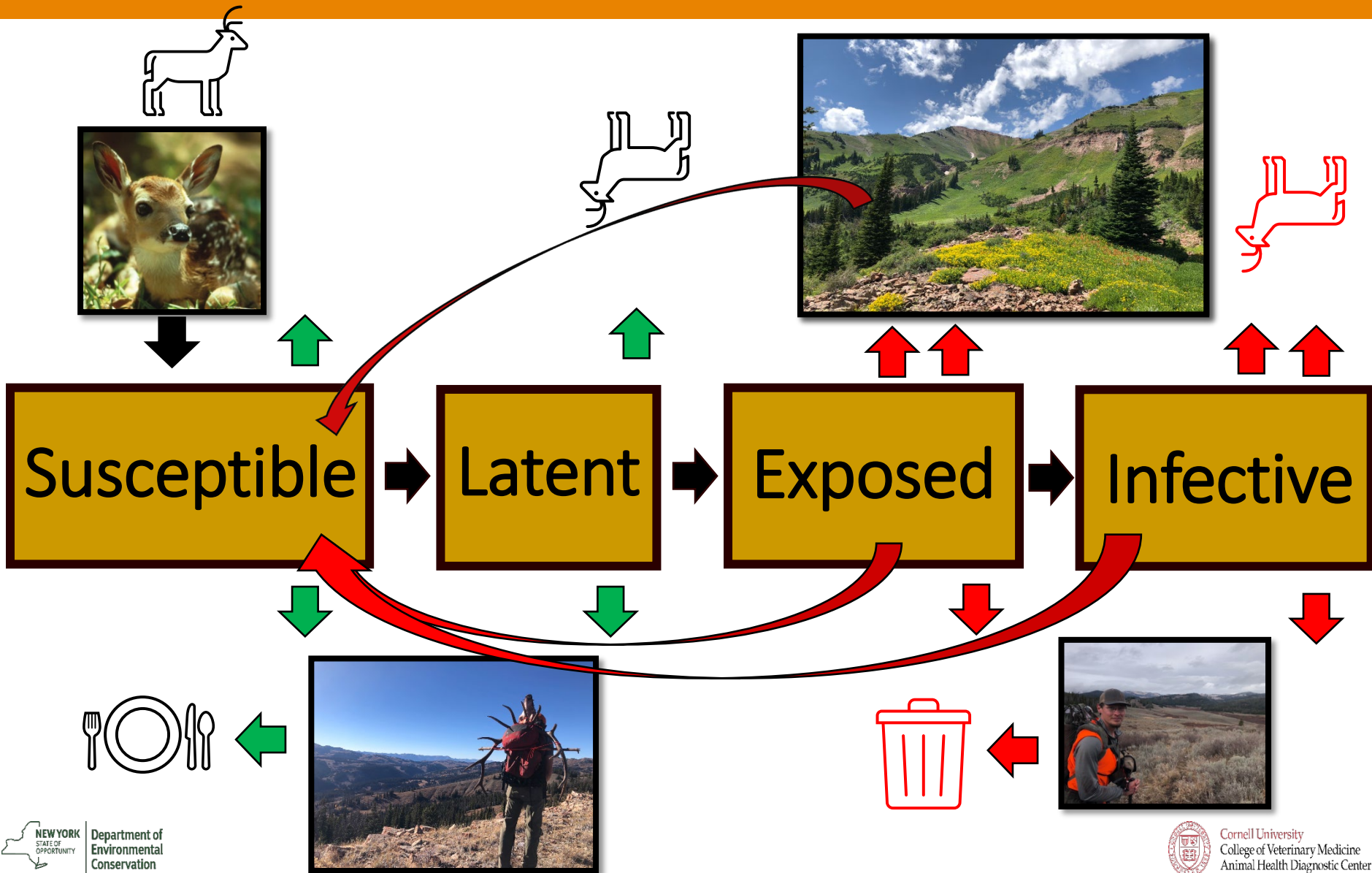
SLEI Model



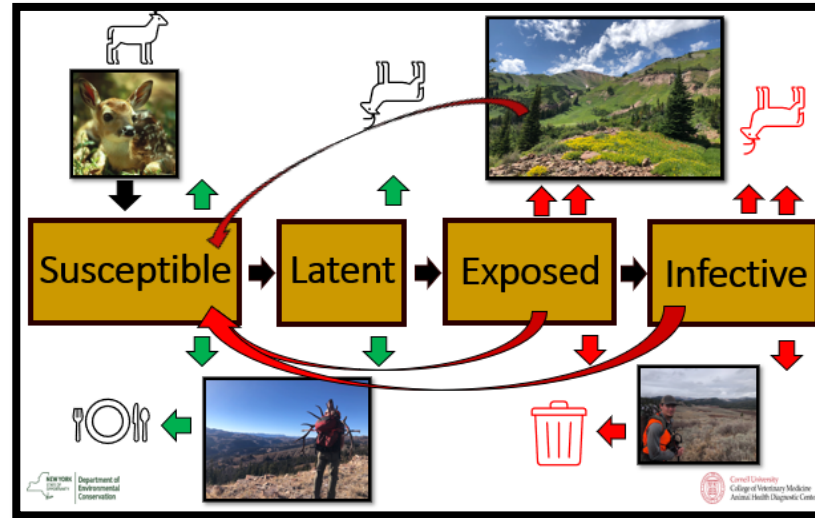
SLEI Model







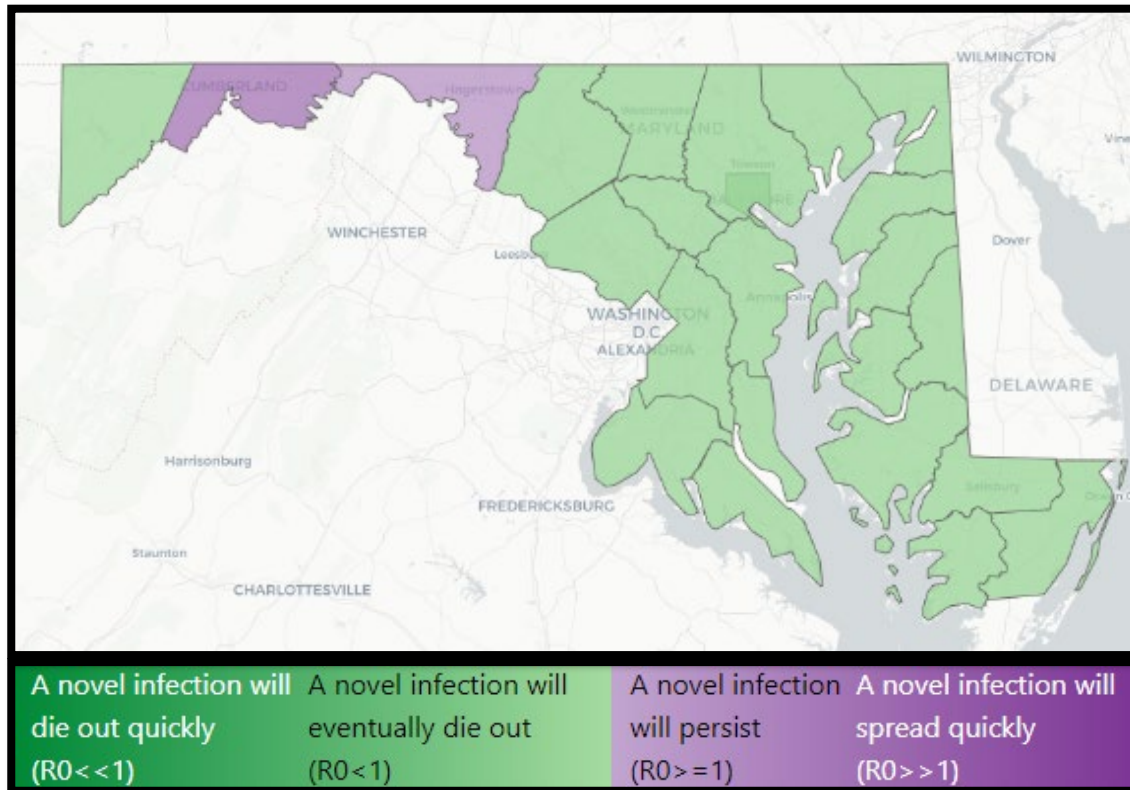
Ergo, if you agree with this model:



Then a novel infection in the live population fails to persist (i.e., $R_0 < 1$) when:

$$\mu_S N^q \eta (\mu_L + \omega) (\mu_{Ew} + \mu_{Ed} + \epsilon) (\mu_{Iw} + \mu_{Id} + \alpha) > \gamma_E f \omega \eta (\mu_{Iw} + \mu_{Id} + \alpha) + \gamma_I f \omega \epsilon \eta + \sigma f \omega N^q (\theta_E + \phi_E \mu_{Ed}) (\mu_{Iw} + \mu_{Id} + \alpha) + \sigma f \omega \epsilon N^q (\theta_I + \phi_I \mu_{Id} + \phi_X \alpha)$$

Given the demographic data in the Warehouse, if prions were introduced into **an otherwise healthy herd**, then the model suggests how the **underlying population dynamics** would act on the disease.



Given data uploaded into the Warehouse from the states, this model will run immediately.

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Adapted in the Warehouse from:

Hanley et al. 2022. SEI Model Software. Cornell University Library eCommons Repository. DOI: 10.7298/csew-h225.

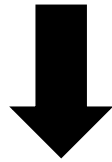


We want to pinpoint a CWD surveillance program that **maximizes the benefit of surveillance to the agency** while **staying within allowable surveillance cost.**

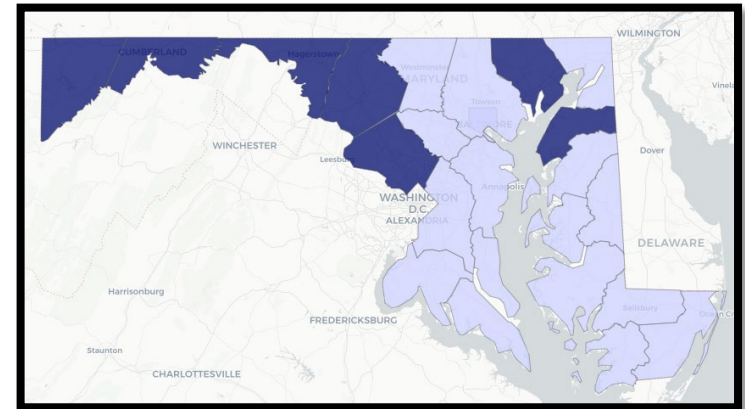
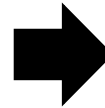


Hanley et al. A Tool to Allocate Surveillance Resources of Chronic Wasting Disease. In Preparation.

Costs of Sampling



Landscape of Cost



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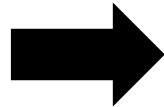
Adapted in the Warehouse from:

Hanley et al. 2023. Chronic Wasting Disease Surveillance Optimization Software.

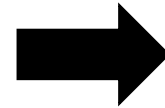
Cornell University Library eCommons Repository. DOI: 10.7298/c8xm-wx39.



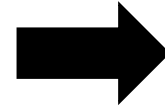
Benefits of Sampling



**>700,000
individual
deer
sampled
for CWD**



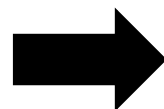
**14,616 unique
county/season-year
combinations**



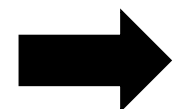
35 covariates



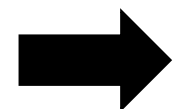
Benefits of Sampling



>700,000 individual deer sampled for CWD



14,616 unique county/season-year combinations



35 covariates



CWD Event	Surveillance Category	Year T	Year T+1	Conditions
0-1	First Detection	No CWD	CWD	No CWD anywhere near
0-1	Early Detection	No CWD	CWD	CWD in an adjacent area
1-1	Monitoring	CWD	More CWD	--

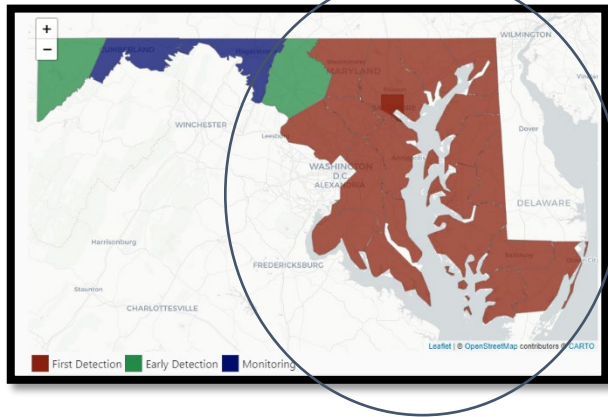
Adapted in the Warehouse from:

Them et al. Chronic Wasting Disease Benefit of Surveillance Matrix Software. Cornell University Library eCommons Repository. DOI: 10.7298/xc5z-hs96.

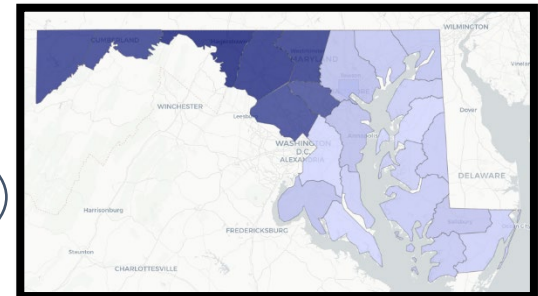
Benefits of Sampling

Landscape of Benefits

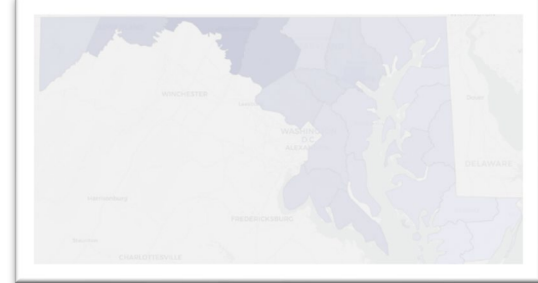
Eligible Counties



First Detection



Early Detection



Monitoring



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Adapted in the Warehouse from:

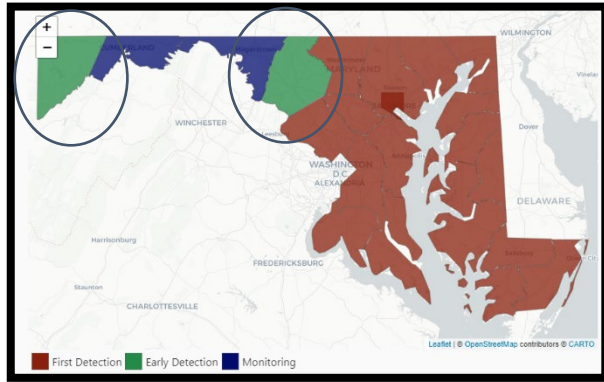
Hanley et al. 2023. Chronic Wasting Disease Surveillance Optimization Software.

Cornell University Library eCommons Repository. DOI: 10.7298/c8xm-wx39.



Benefits of Sampling

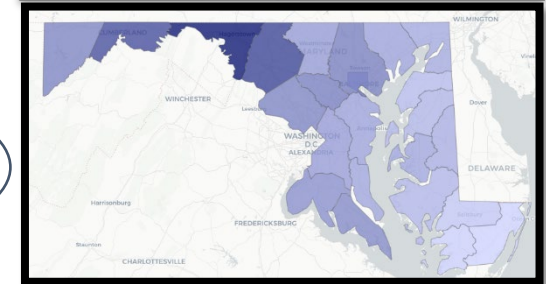
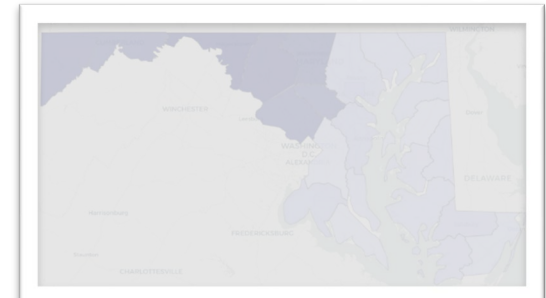
Eligible Counties



First Detection

Early Detection

Monitoring



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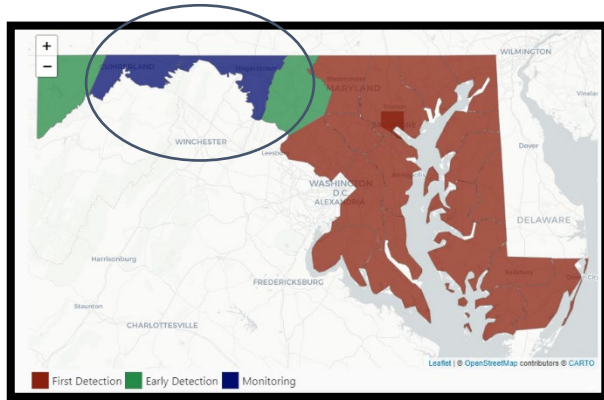
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Hanley et al. 2023. Chronic Wasting Disease Surveillance Optimization Software.

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Benefits of Sampling

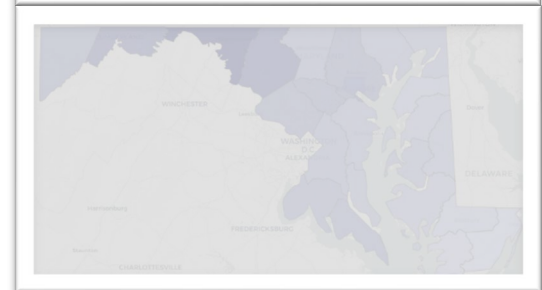
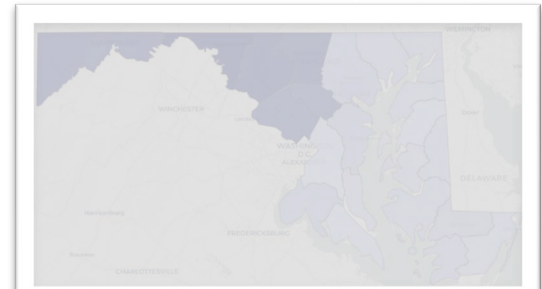
Eligible Counties



First Detection

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Monitoring



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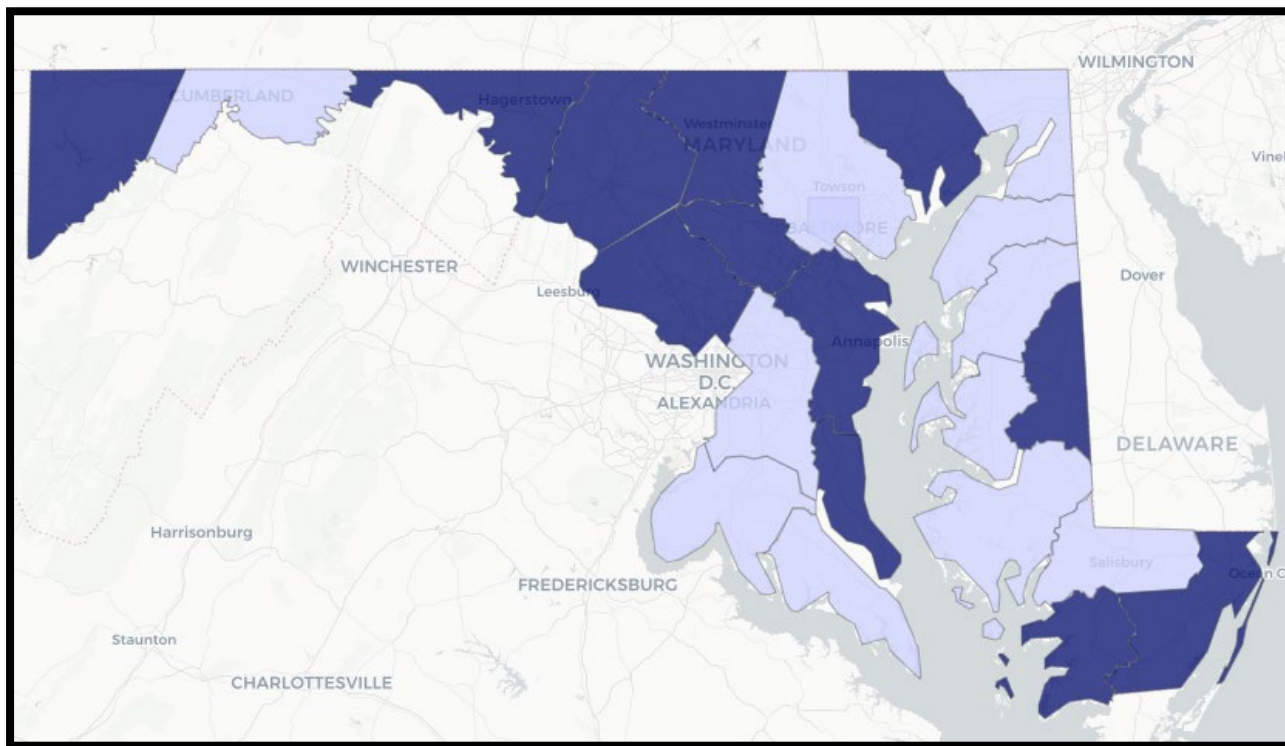
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Hanley et al. 2023. Chronic Wasting Disease Surveillance Optimization Software.

Cornell University Library eCommons Repository. DOI: 10.7298/c8xm-wx39.



Given the user inputs and data in the Warehouse, the optimization model suggests that intensive surveillance should occur in the following locations:



The CWHL must preprocess data before this model can be run in new states.

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Hanley et al. 2023. Chronic Wasting Disease Surveillance Optimization Software. Cornell University Library eCommons Repository. DOI: 10.7298/c8xm-wx39.

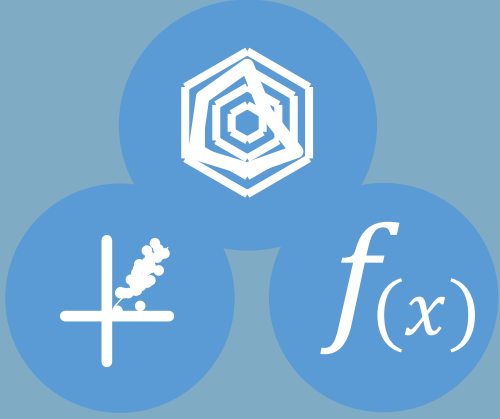


Organizational Infrastructure


Agency Participation




The Warehouse



Current Models and Outputs



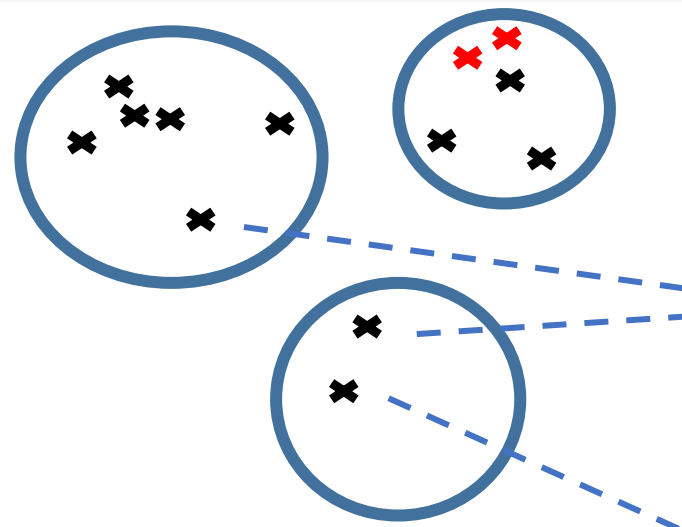
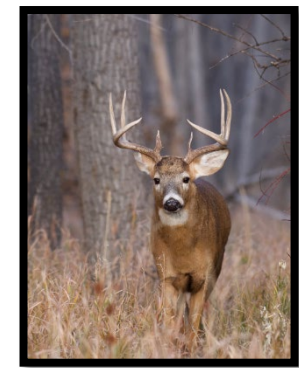
Pending Models



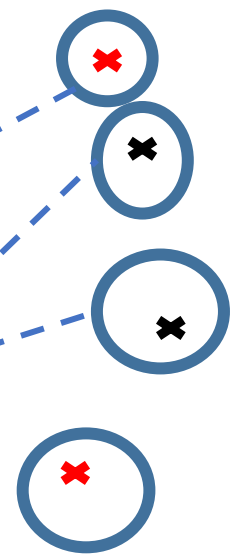
The Future

--Pending-- SOP4CWD Capacity

Biologically Focused Sample Size Model



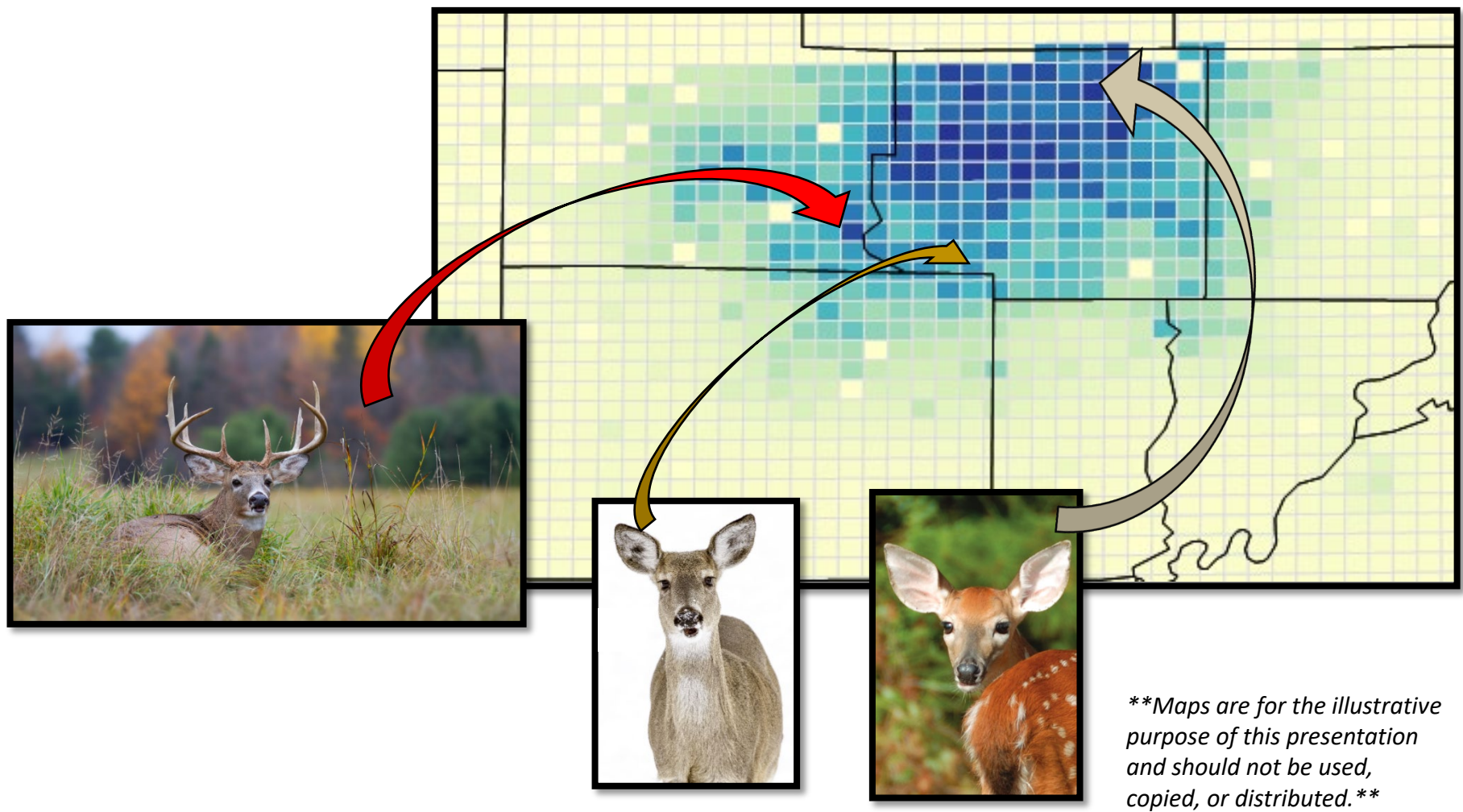
Species	Age	Sex	Date	Tissue	Source
white-tailed	Yearling	Female	11/8/2020	Lymph No	Hunter harvest
white-tailed	Adult	Male	11/7/2020	Lymph No	Hunter harvest
white-tailed	Adult	Male	11/7/2020	Lymph No	Hunter harvest
white-tailed	Yearling	Male	11/7/2020	Lymph No	Hunter harvest
white-tailed	Adult	Male	11/7/2020	Lymph No	Hunter harvest
white-tailed	Yearling	Female	11/8/2020	Lymph No	Hunter harvest
white-tailed	Adult	Female	11/7/2020	Lymph No	Hunter harvest
white-tailed	Adult	Female	11/8/2020	Lymph No	Hunter harvest
white-tailed	Adult	Male	11/7/2020	Lymph No	Hunter harvest
white-tailed	Adult	Male	11/3/2020	Lymph No	Hunter harvest
white-tailed	Fawn	Female	11/8/2020	Lymph No	Hunter harvest
white-tailed	Yearling	Male	11/7/2020	Lymph No	Hunter harvest
white-tailed	Yearling	Male	11/7/2020	Lymph No	Hunter harvest
white-tailed	Yearling	Female	11/7/2020	Lymph No	Hunter harvest
white-tailed	Yearling	Female	11/7/2020	Lymph No	Hunter harvest
white-tailed	Adult	Female	11/8/2020	Lymph No	Hunter harvest



Booth et al. Sample Size for Estimating Disease Prevalence in Free-Ranging Wildlife Populations. In Peer Revision.

--Pending-- SOP4CWD Capacity

Habitat Risk Model

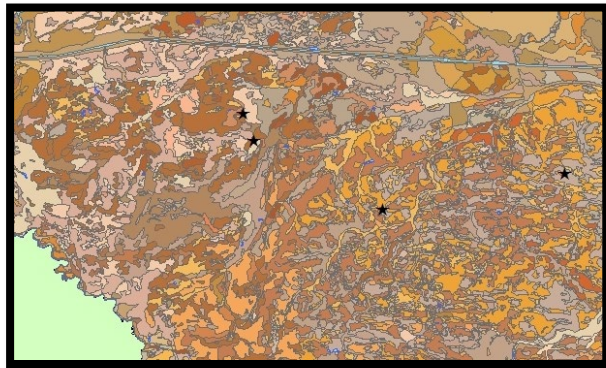


****Maps are for the illustrative purpose of this presentation and should not be used, copied, or distributed.****

Walter et al. Predicting the Odds of Chronic Wasting Disease With the Habitat Risk Software. In Preparation.

--Pending-- SOP4CWD Capacity

Agent-Based Model



****Maps are for the illustrative purpose of this presentation and should not be used, copied, or distributed.****

Gonzalez-Crespo et al. Using a Spatially-Explicit Agent-Based Disease Spread Model for Chronic Wasting Disease. In Preparation.

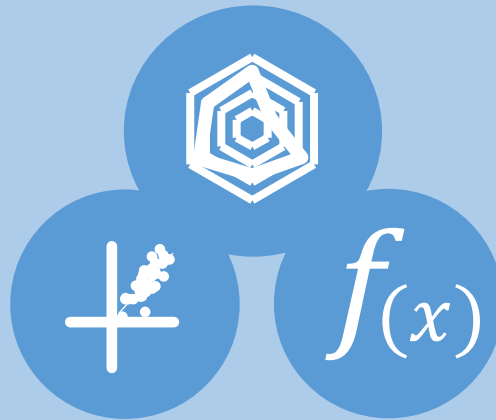


Organizational Infrastructure

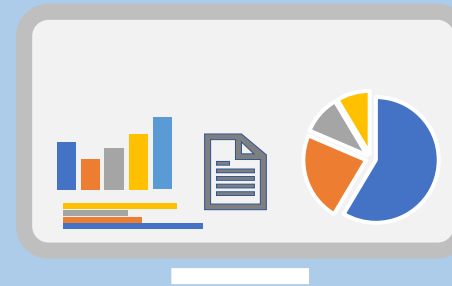
Agency
Participation



The Warehouse



Current Models
and Outputs



Pending
Models



The Future



--Future-- Warehouse Models?

Linking Models With Data to Benefit Agencies

Prevalence Models



--Future-- Warehouse Models?

Linking Models With Data to Benefit Agencies

Spatial Diffusion Models

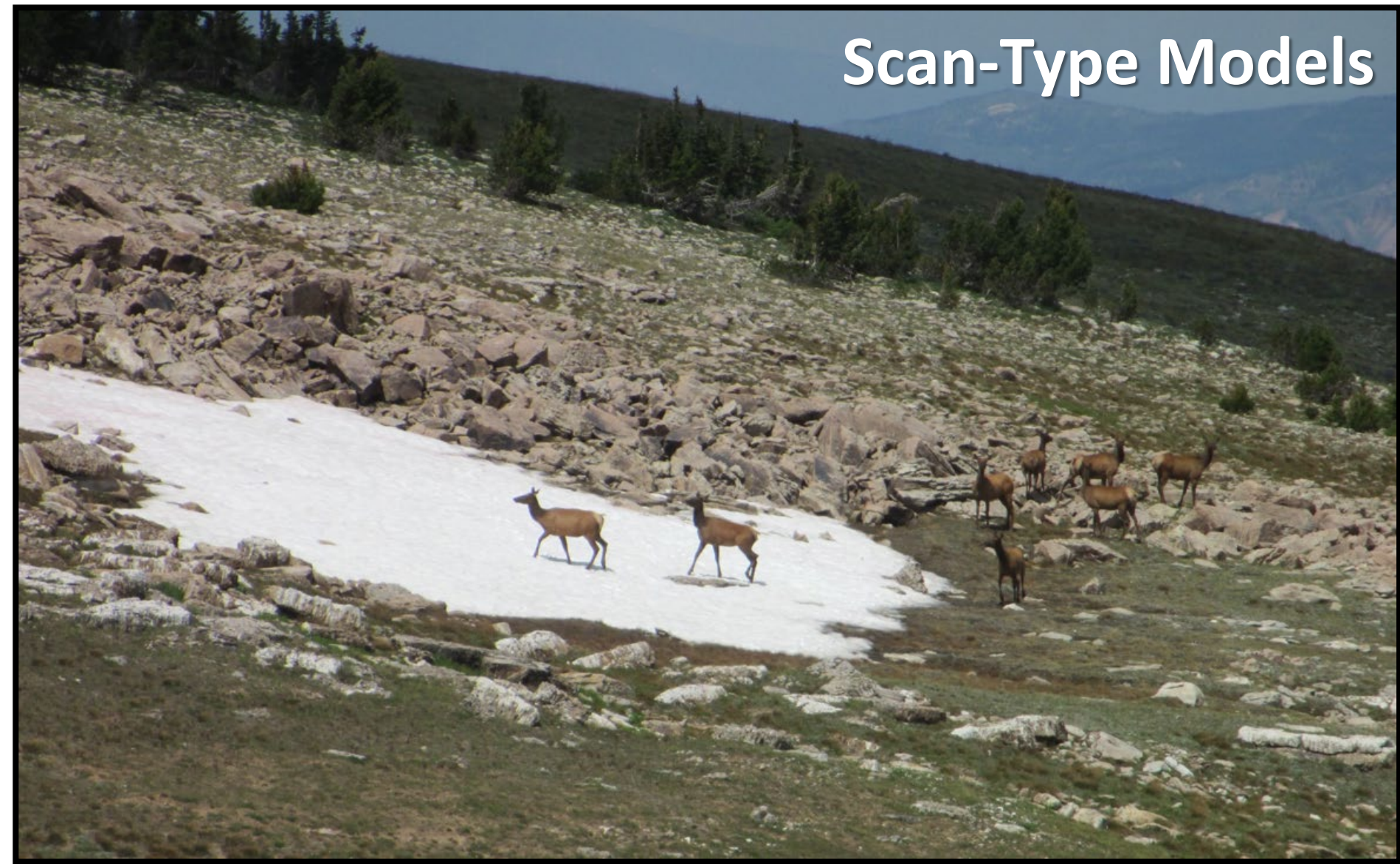




--Future-- Warehouse Models?

Linking Models With Data to Benefit Agencies

Scan-Type Models





--Future-- Warehouse Models?

Linking Models With Data to Benefit Agencies

Machine Learning Models





--Future-- Warehouse Models?

Linking Models With Data to Benefit Agencies

Structured Decision Models





--Future-- Warehouse Models?

Linking Models With Data to Benefit Agencies

Home Range Models



--Future-- Warehouse Models?

Contact sop4cwd@cornell.edu

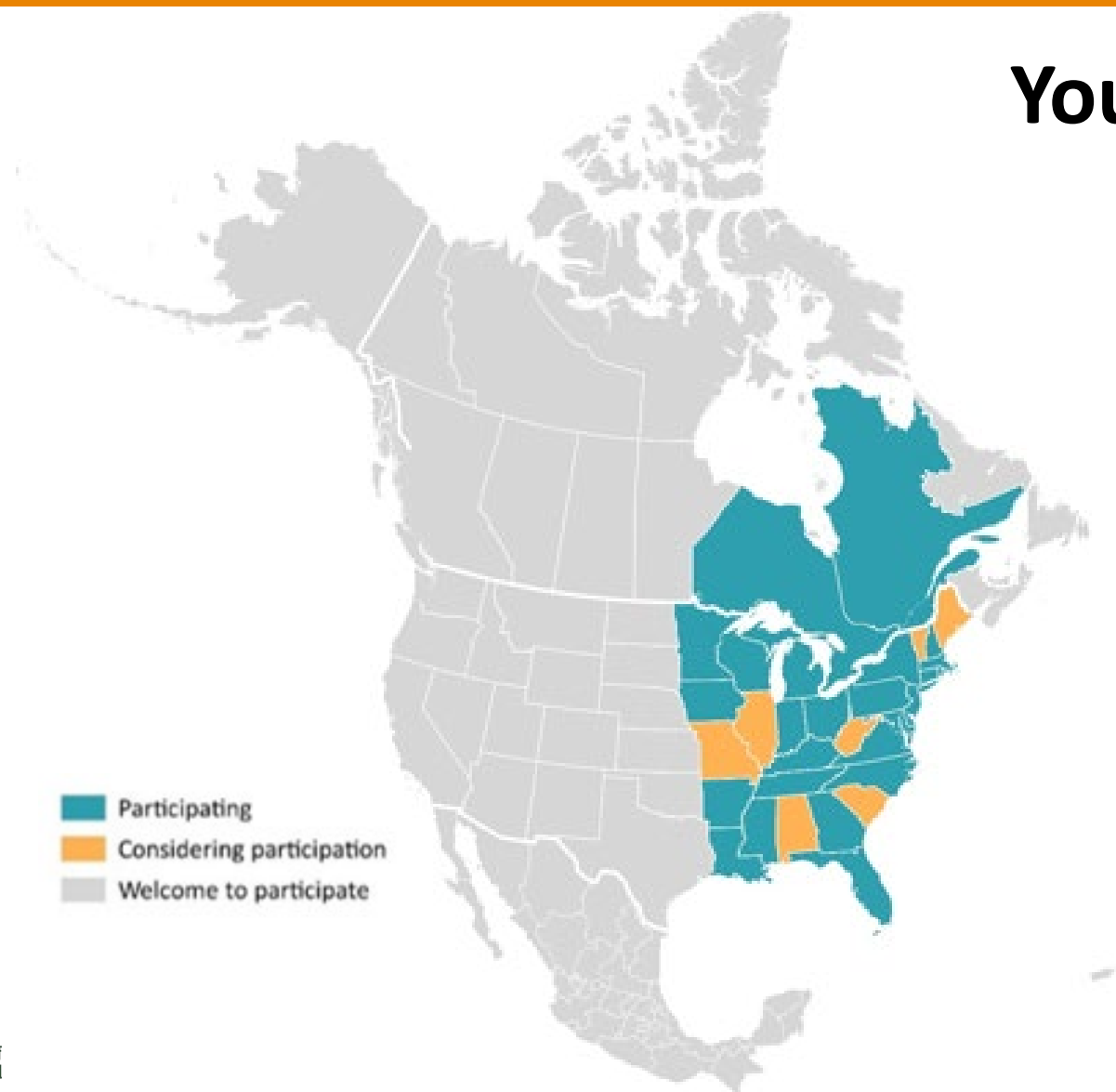
Your Model?



--Future-- Project Partners?

Contact sop4cwd@cornell.edu

Your Agency?



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SOP4CWD

Improving CWD Surveillance Through "Big Data" Infrastructure