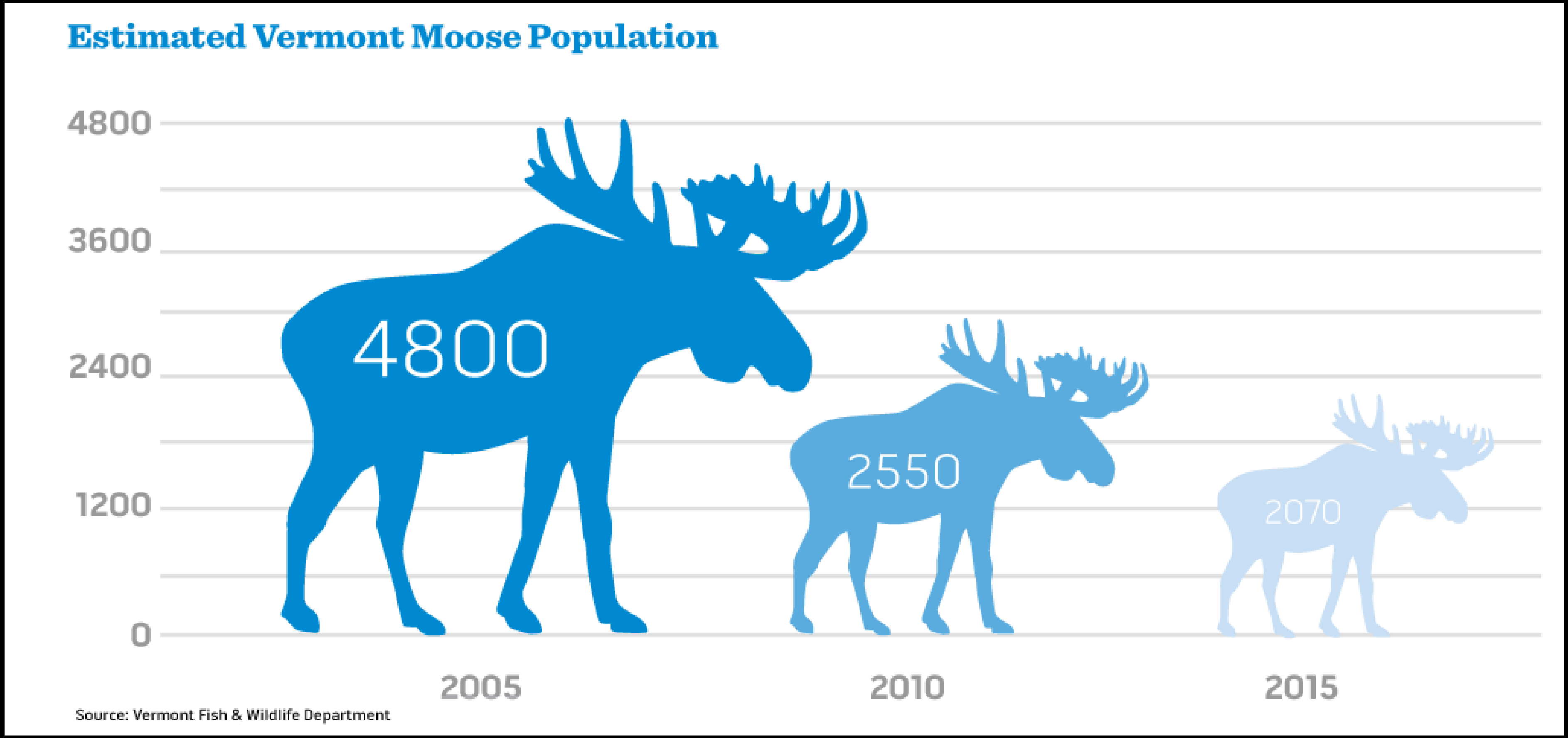
Modeling Moose Habitat Suitability by Age, Sex, and Season in Vermont, USA based on GPS Radio-collar Data and Lidar Imagery

Joshua A. Blouin[1], Jacob DeBow[1], Elias Rosenblatt[1], Cedric Alexander[2], Katherina Gieder[2], Nicholas Fortin[2], James Murdoch[3], Therese Donovan[4]

[1]Vermont Cooperative Fish and Wildlife Research Unit
[2]Vermont Fish and Wildlife Department
[3]University of Vermont
[4]USGS Vermont Cooperative Fish and Wildlife Research Unit

Moose Population Trends in Vermont

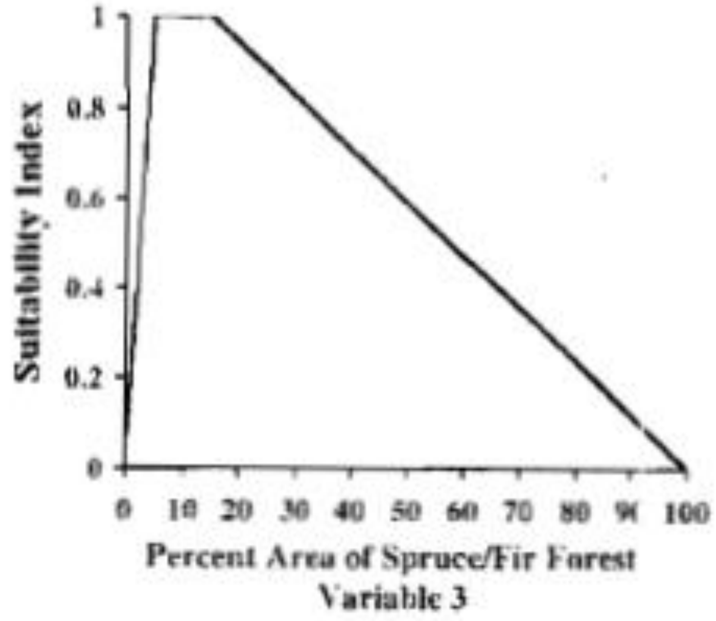


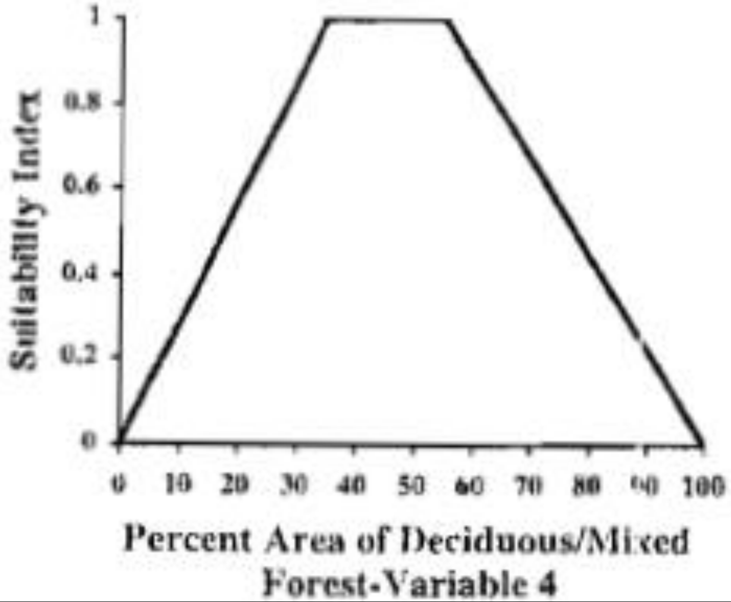
Winter Tick(Dermacentor albipictus)

The Big Picture

Understanding the relative suitability of habitats in a landscape provides a foundation for wildlife population management and is especially important for a species in decline.

What we know about moose habitat in VT





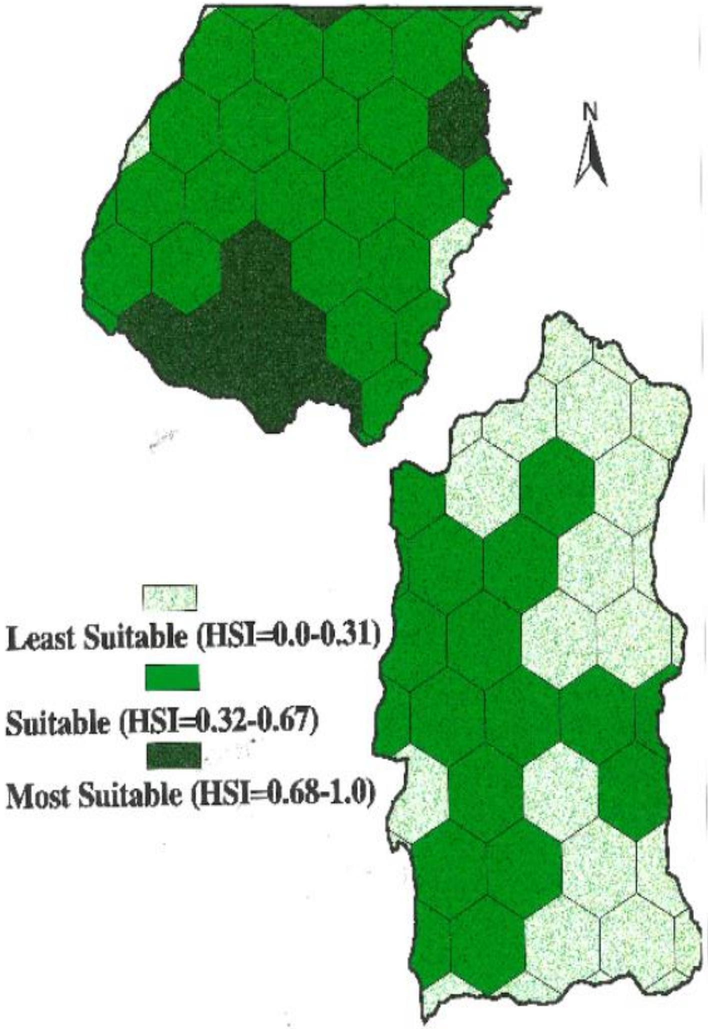


Figure 8. Relative habitat suitability indices of 25-km^2 evaluation units for WMUs. "Least suitable" units had suitability indices between 0.0 and 0.31, "suitable" between 0.32and 0.66, and "most suitable" between 0.67 and 1.0.

68

- A HSI for moose was developed by the USFWS in the 1980s (Allen et al. 1987) and applied to WMUs E1 and I Vermont in the early 2000s (Koitzsch 2002).
- Although this HSI has informed management in the state and made use of the best available information on moose at the time, it has several limitations.

An upgraded HSI model for moose in Vermont was developed based on three new sources of information:

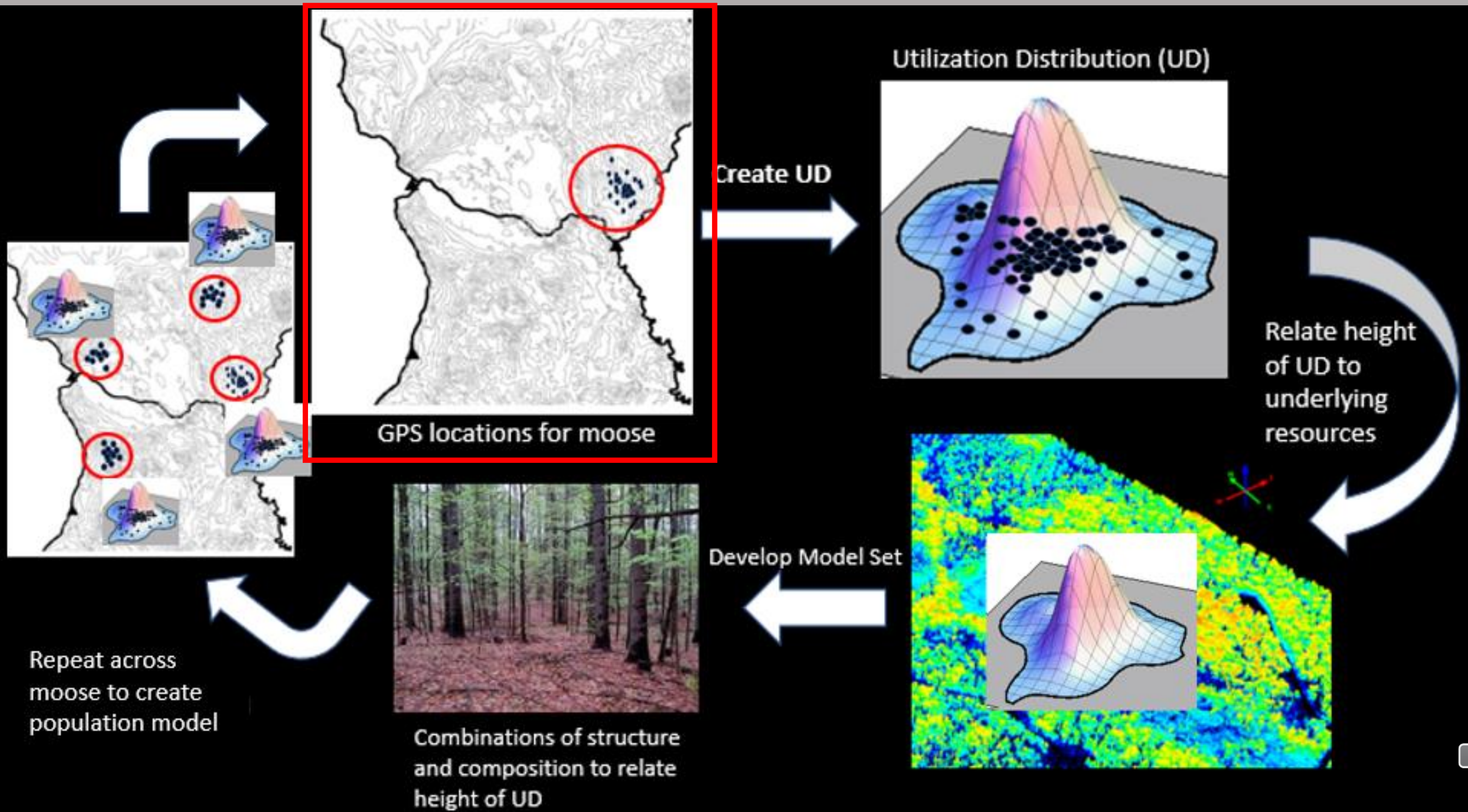
1. GPS radio-collar locations of moose (approx. 45,000 collected to-date)
2. Contemporary maps of land cover types (from the newly available 2016 National Land Cover Database)
3. Fine-scale landscape conditions from 2016 LIDAR (*light detection and ranging*) imagery

Objectives

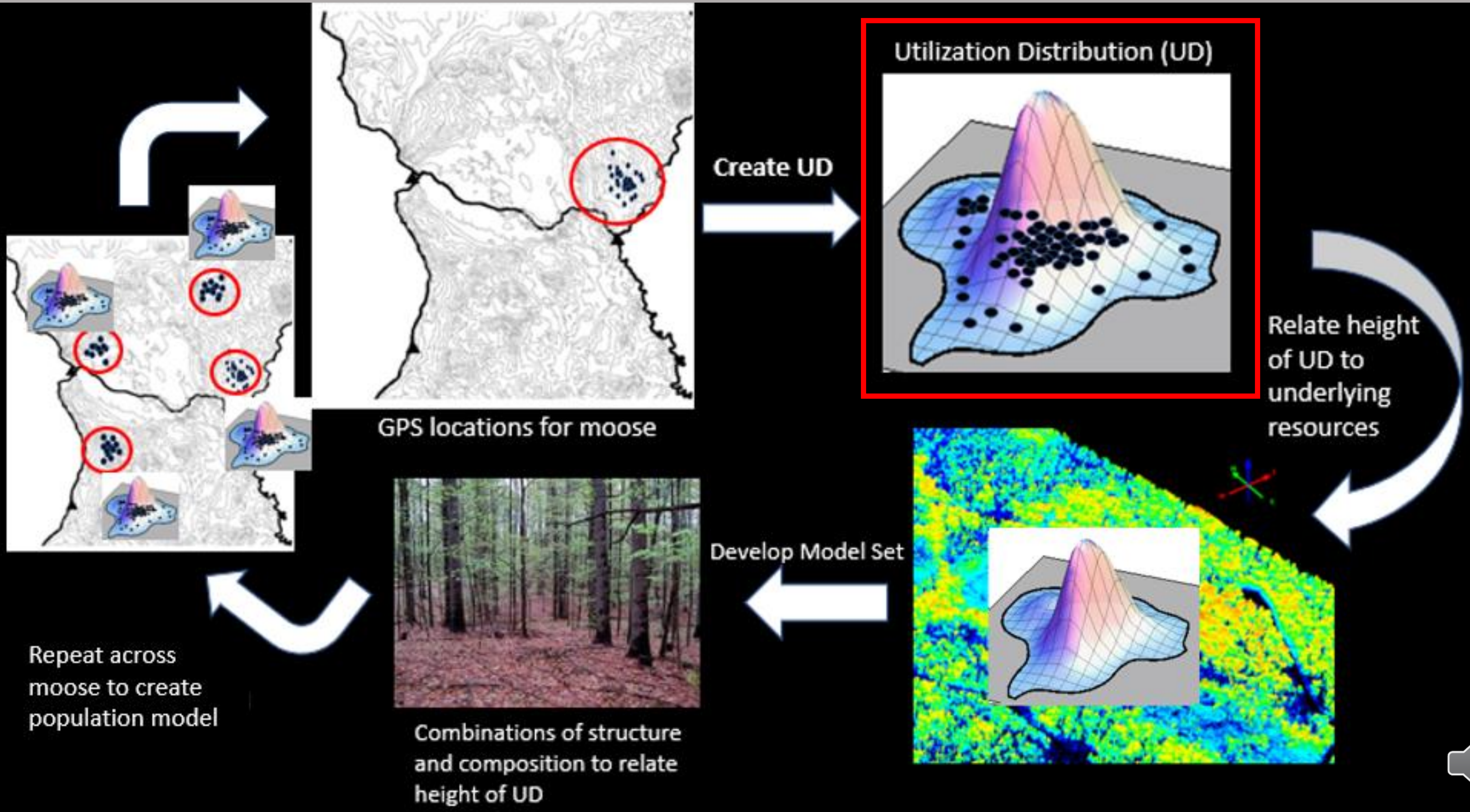
- Develop contemporary habitat suitability models by age (mature and young adult), season (dormant and growth), and sex.

- Map suitability across the study area.

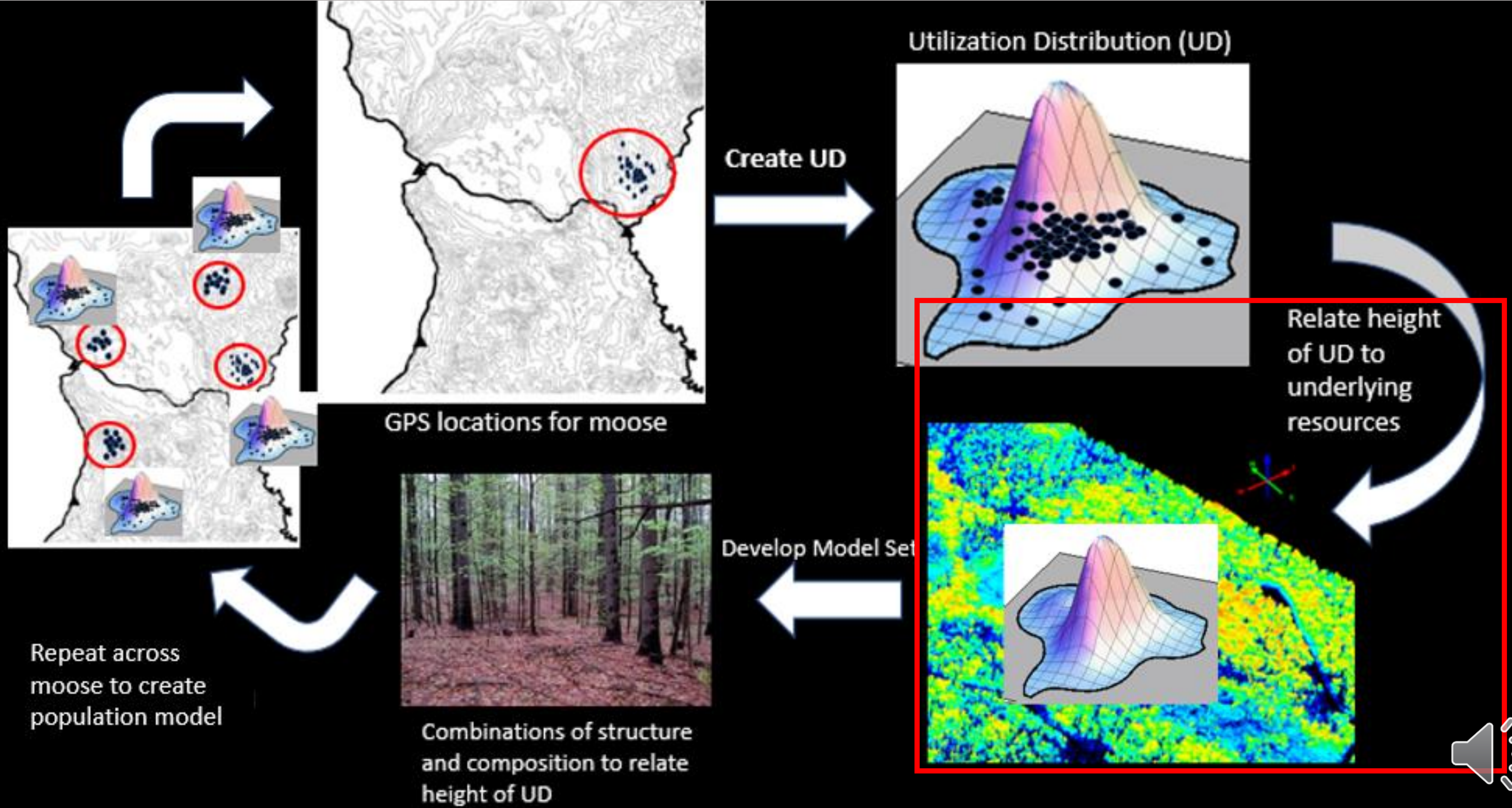
Methods Objective 1 –
Step 1: GPS Locations and filtering



Methods Objective 1 –
Step 2: Create the Utilization Distributions (UD)



Methods Objective 1 –
Step 3: Relate height of UD to underlying resources

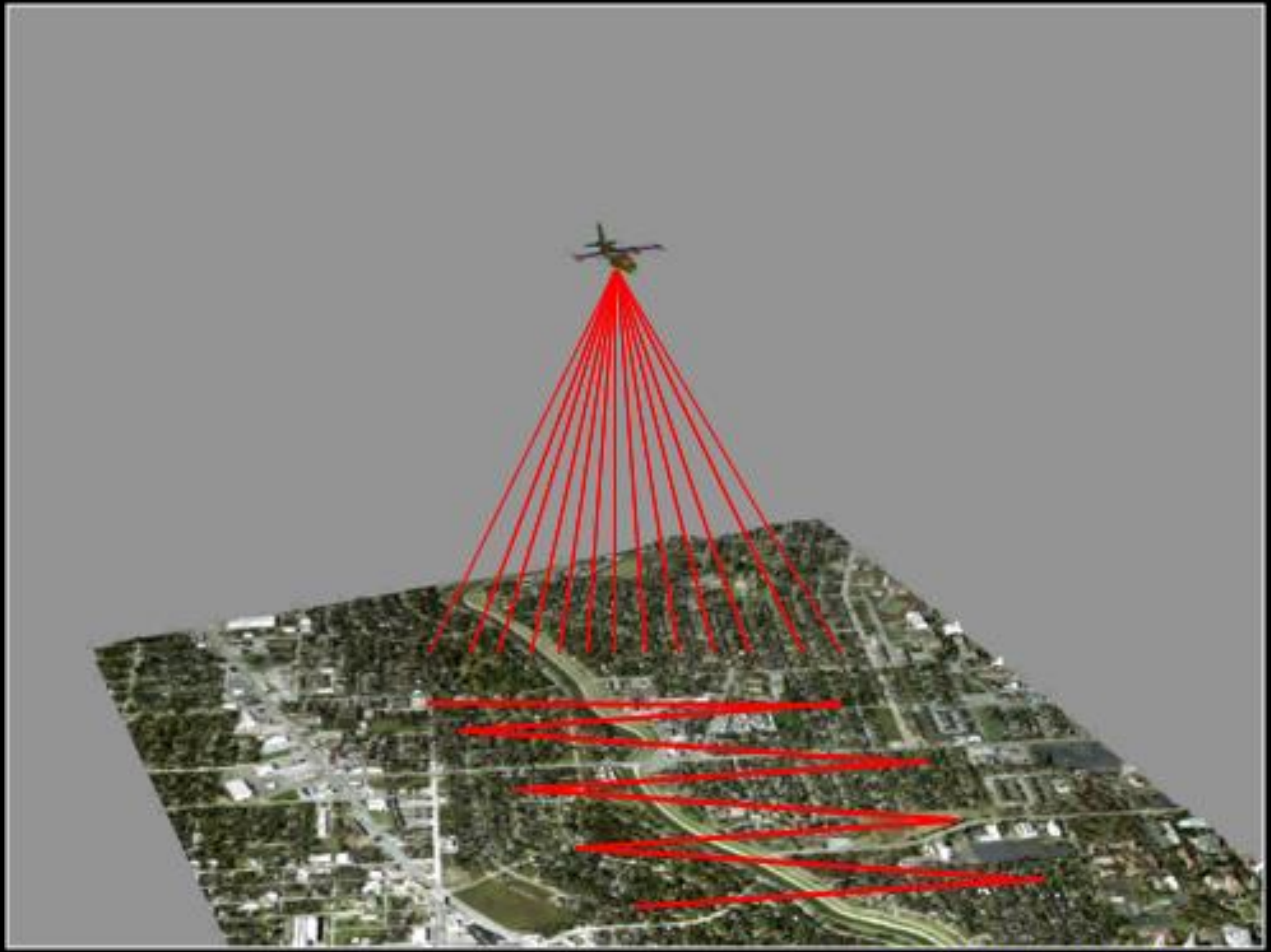


Methods Objective 1 –

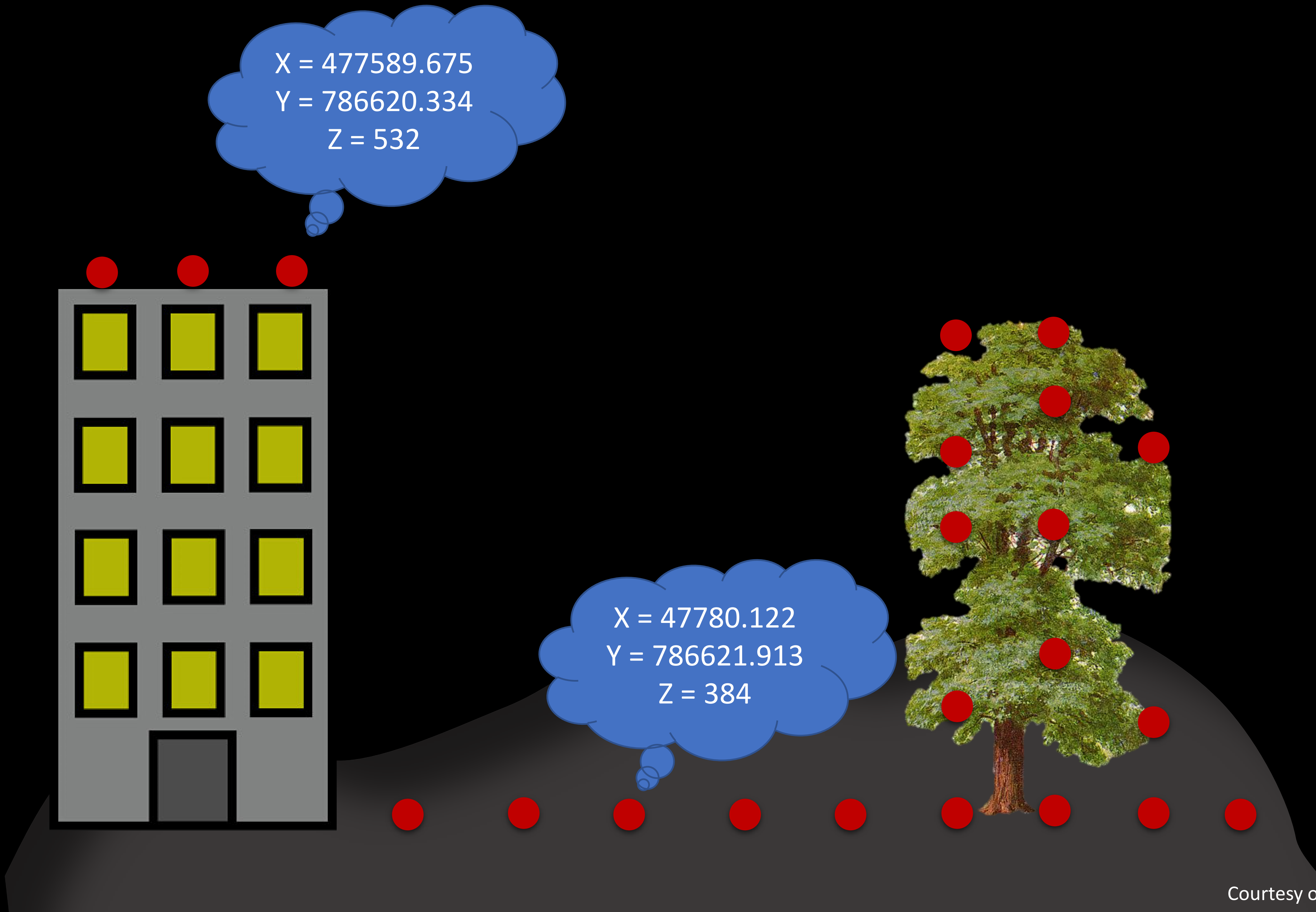
Step 3: Relate height of UD to underlying resources

Covariate Name	Description	Data Source	Reference
P_Open	Proportion of each home range that was defined as "open" (vegetation between 0.00 - 0.02 m) at a 10 m^2 resolution.	Lidar 2016	USGS 2016b
P_Shrub	Proportion of each home range that was defined as "shrub" (vegetation between > 0.02 - ≤ 2.0 m) at a 10 m^2 resolution. Defined because of its potential importance to moose as a food source, but also to winter ticks as they tend to quest (or seek a host) within this height range.	Lidar 2016	USGS 2016b
P_Forage	Proportion of each home range that was defined as potential "forage" (vegetation ≤ 3.0 m) or vegetation that was within reach of moose at a 10 m^2 resolution.	Lidar 2016	USGS 2016b
P_Cover	Proportion of each home range that was defined as "cover" (vegetation between > 3.0 - < 6.0 m) at a 10 m^2 resolution.	Lidar 2016	USGS 2016b
P_Canopy	Proportion of each home range that was defined as "canopy" (vegetation > 6.0 m) at a 10 m^2 resolution. Defined because of its potential importance to moose as a source of protection for thermal stress or shelter during periods of deep snow.	Lidar 2016	USGS 2016b
P_Wetland	Proportion of each home range defined as "wetland" forest (NLCD emergent and woody wetland classifications were combined to represent general wetlands) at a 30 m^2 resolution.	NLCD 2016	USGS 2016b
P_Deciduous	Proportion of each home range defined as "deciduous" forest (> 75% of the tree species shed foliage simultaneously in response to seasonal change) at a 30 m^2 resolution.	NLCD 2016	USGS 2016a
P_Evergreen	Proportion of each home range defined as "evergreen" forest (> 75% of the tree species maintain their leaves all year) at a 30 m^2 resolution.	NLCD 2016	USGS 2016a
P_Mixed	Proportion of each home range defined as "mixed" forest (Neither deviduous nor evergreen species are > 75% of total tree cover) at a 30 m^2 resolution.	NLCD 2016	USGS 2016a
P_OpenWater	Proportion of each home range defined as "open water" (areas of open water, < 25% cover of vegetation or soil) at a 30 m^2 resolution.	NLCD 2016	USGS 2016a
P_Developed	Proportion of each home range defined as "developed" (indication of impervious surfaces, covering all defintions in NLCD legend to represent all development) at a 30 m^2 resolution.	NLCD 2016	USGS 2016a

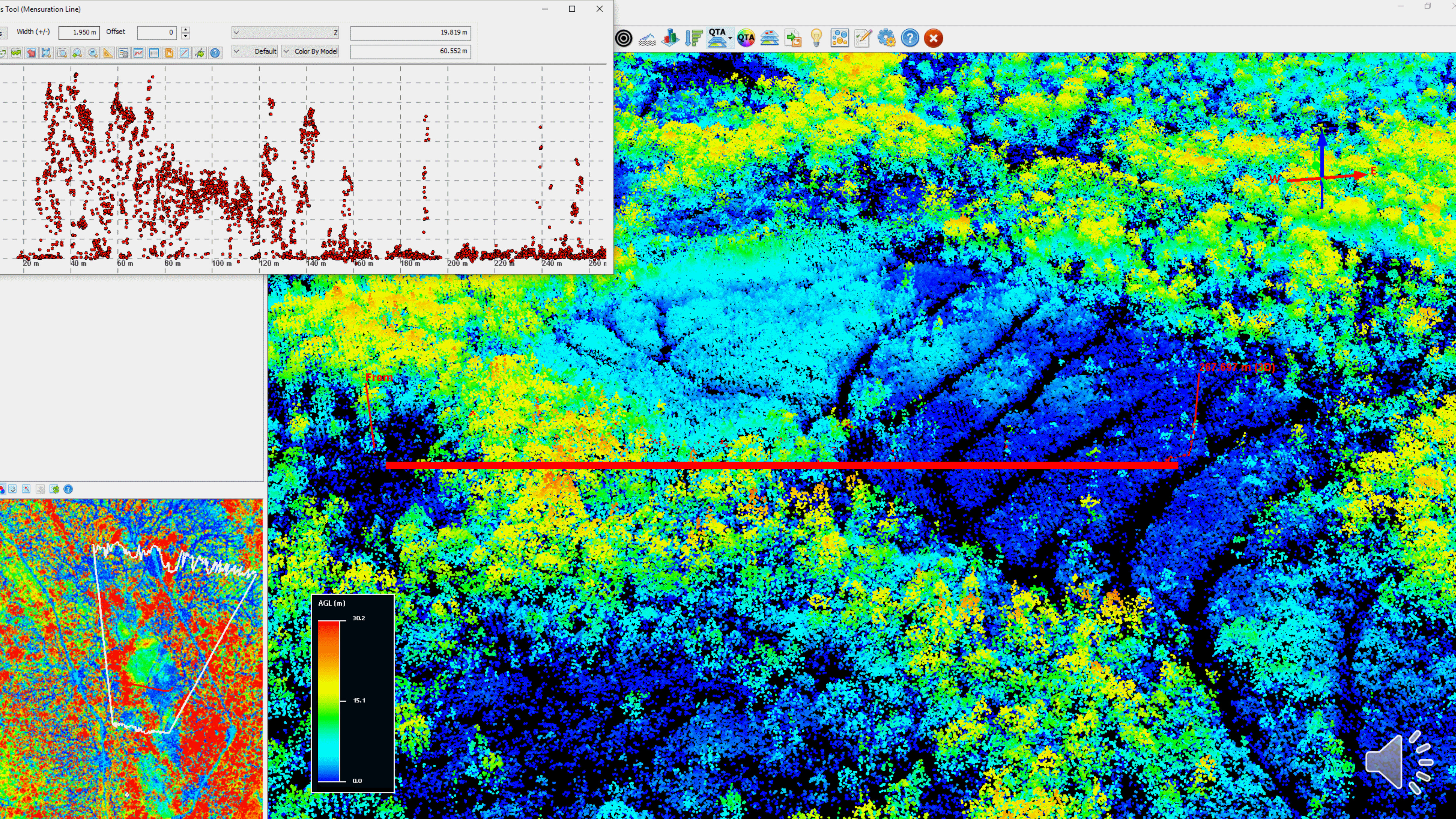
What is LiDAR? How can it improve mapping habitat in the state and region?



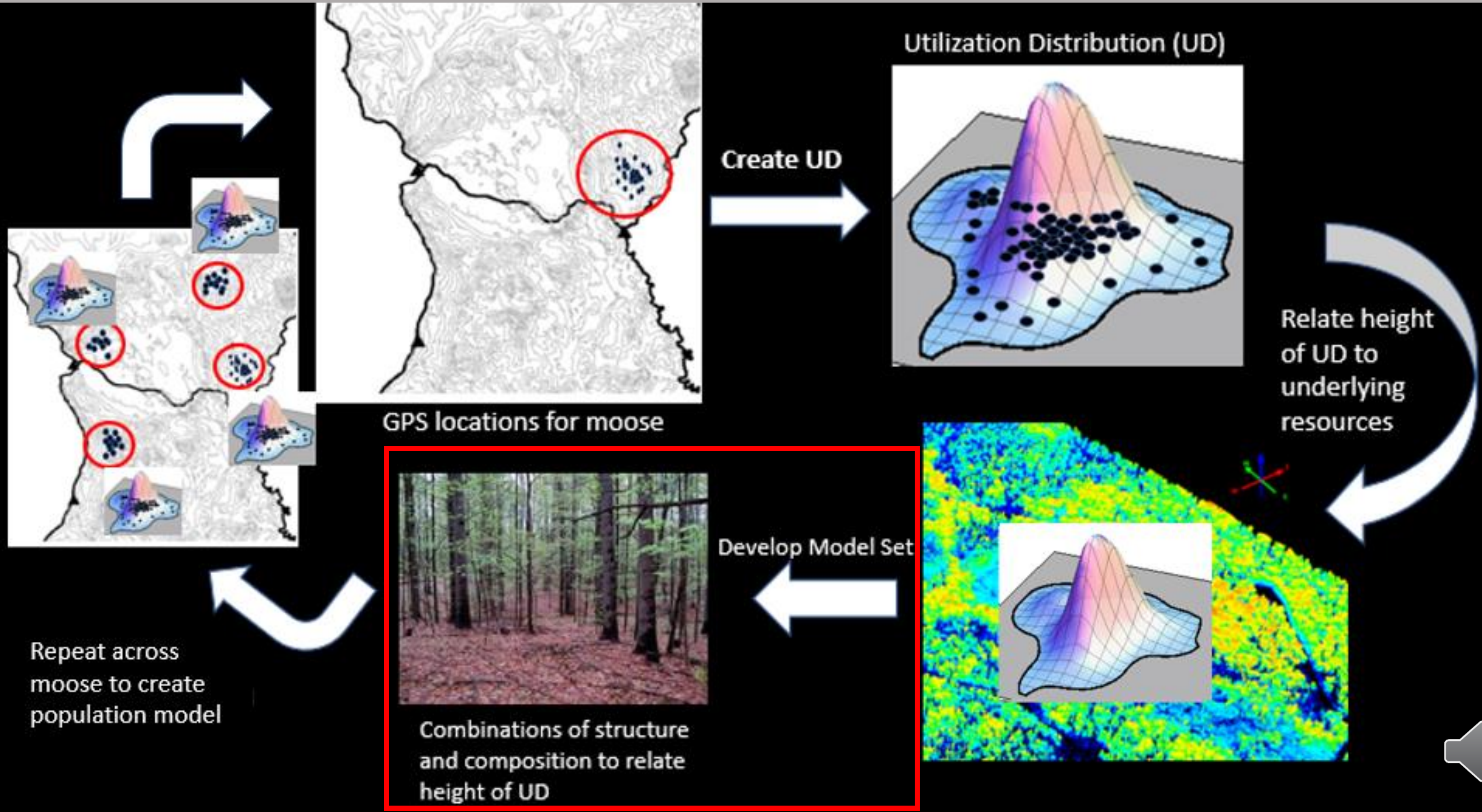
Courtesy of Dodson & Associates



Courtesy of UVM Spatial Lab


s Tool (Mensuration Line)
Width (+/-)
1.950 m
Offset
0
Z
19.819 m
Default
Color By Model
60.552 m
20 m
40 m
60 m
80 m
100 m
120 m
140 m
160 m
180 m
200 m
220 m
240 m
260 m
QTA
W
E
From
AGL (m)
30.2
15.1
0.0

Methods Objective 1 –
Step 4: Develop Model Set

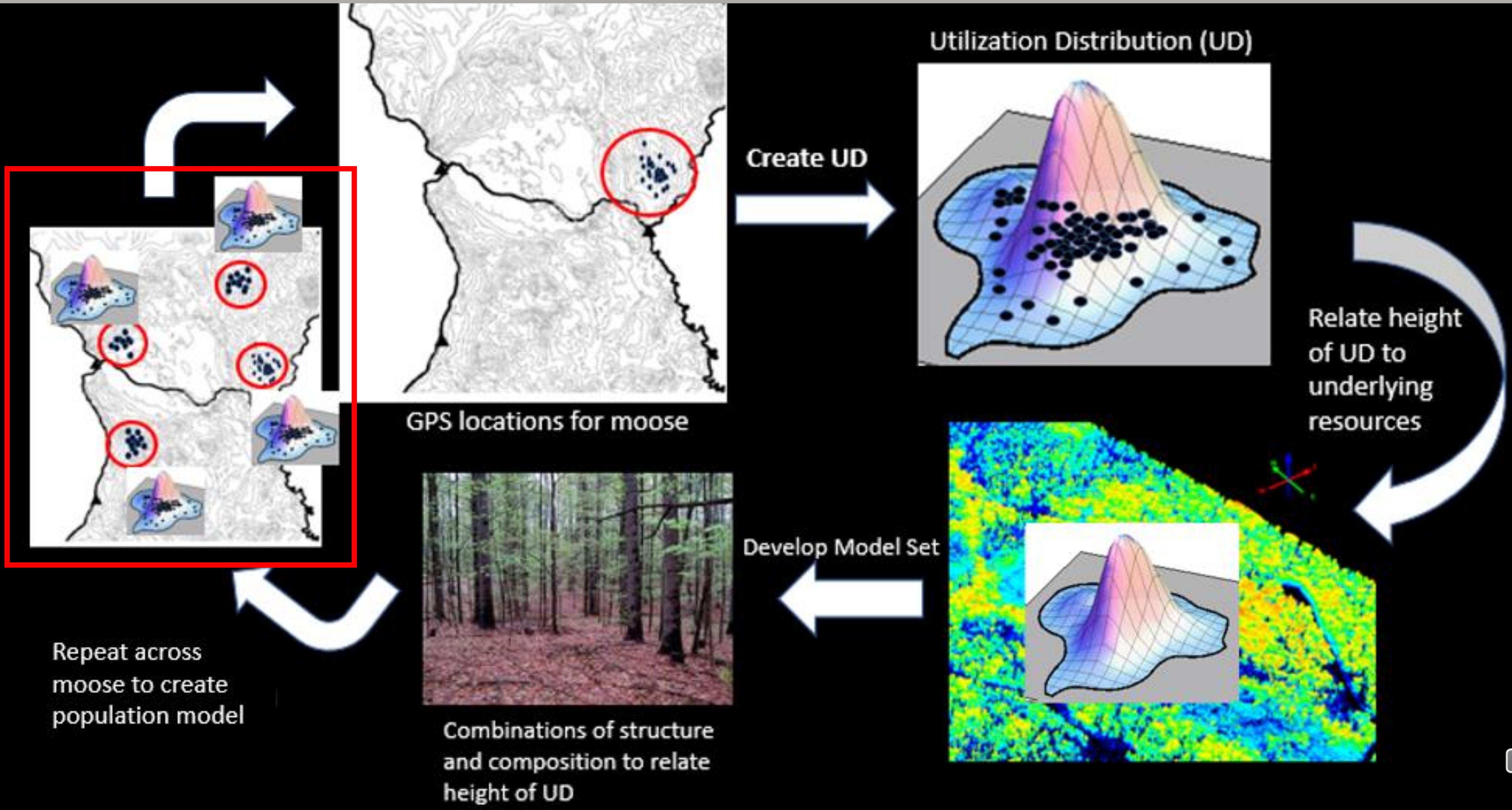


Methods Objective 1 –
Step 4: Develop Model Set

Model	Formula	K
1. Intercept	UDHeight ~ 1	1
2. NLCD (400m) & Lidar (400m)	UDHeight ~ nlcdVariables(400m) + lidarVariables(400m) + Elevation_s	7
3. NLCD (1km) & Lidar (1km)	UDHeight ~ nlcdVariables(1km) + lidarVariables(1km) + Elevation_s	7
4. NLCD (400m) & Lidar (1km)	UDHeight ~ nlcdVariables(400m) + lidarVariables(1km) + Elevation_s	7
5. NLCD (1km) & Lidar (400m)	UDHeight ~ nlcdVariables(1km) + lidarVariables(400m) + Elevation_s	7
6. Lidar (400m)	UDHeight ~ lidarVariables(400m) + Elevation_s	4
7. Lidar (1km)	UDHeight ~ lidarVariables(1km) + Elevation_s	5
8. NLCD (400m)	UDHeight ~ nlcdVariables(400m) + Elevation_s	6
9. NLCD (1km)	UDHeight ~ nlcdVariables(1km) + Elevation_s	6

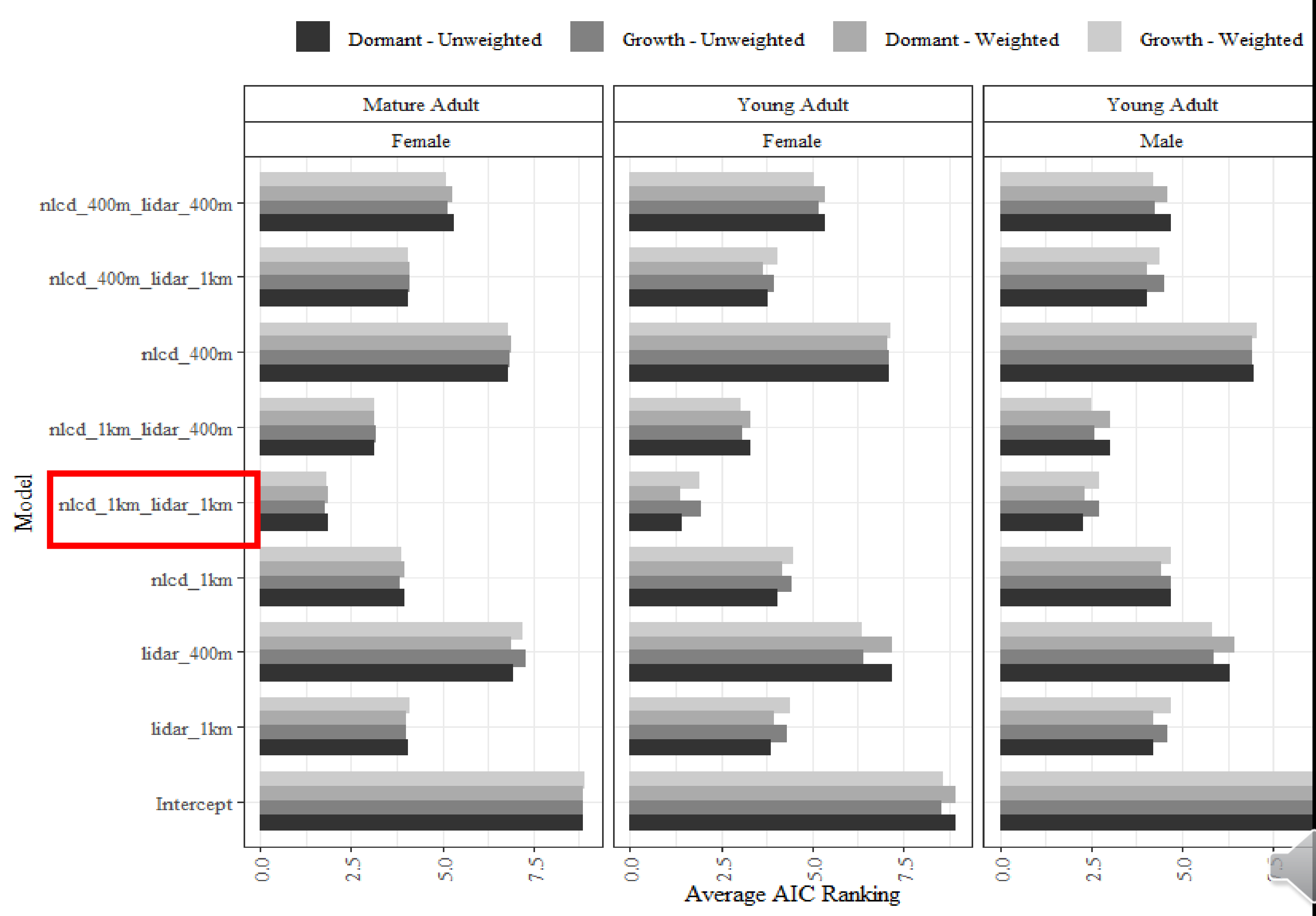
Methods Objective 1 –

Step 5: Repeat across moose to create population model



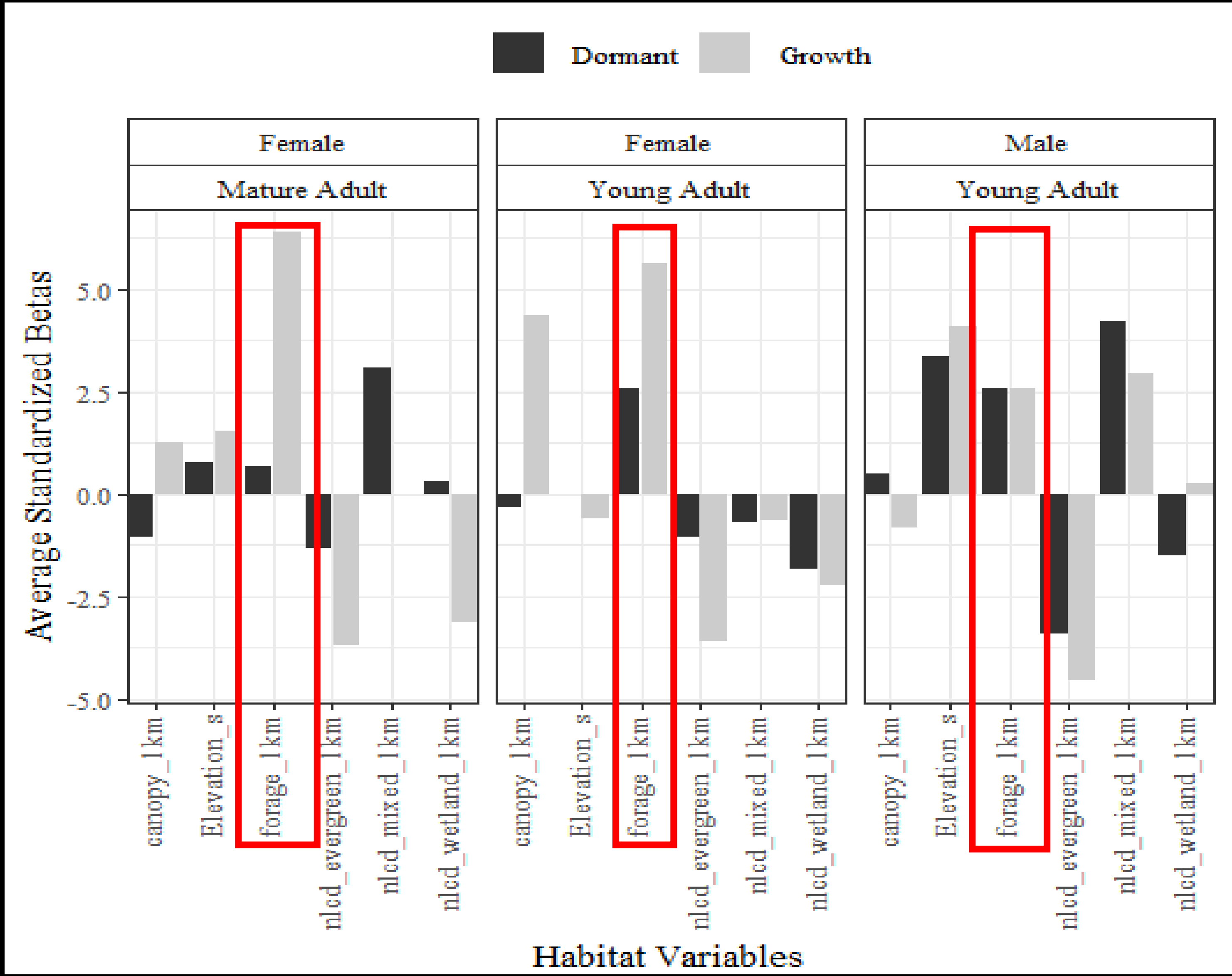
Objective 1 –
Key Results

- Average AIC ranking for each RUF model for moose.
- Models that incorporated both structure and composition were best at predicting habitat use by moose.



Objective 1 –
Key Results

- The relative importance of resources, either negatively or positively, on habitat use, indicated by average standardized betas.

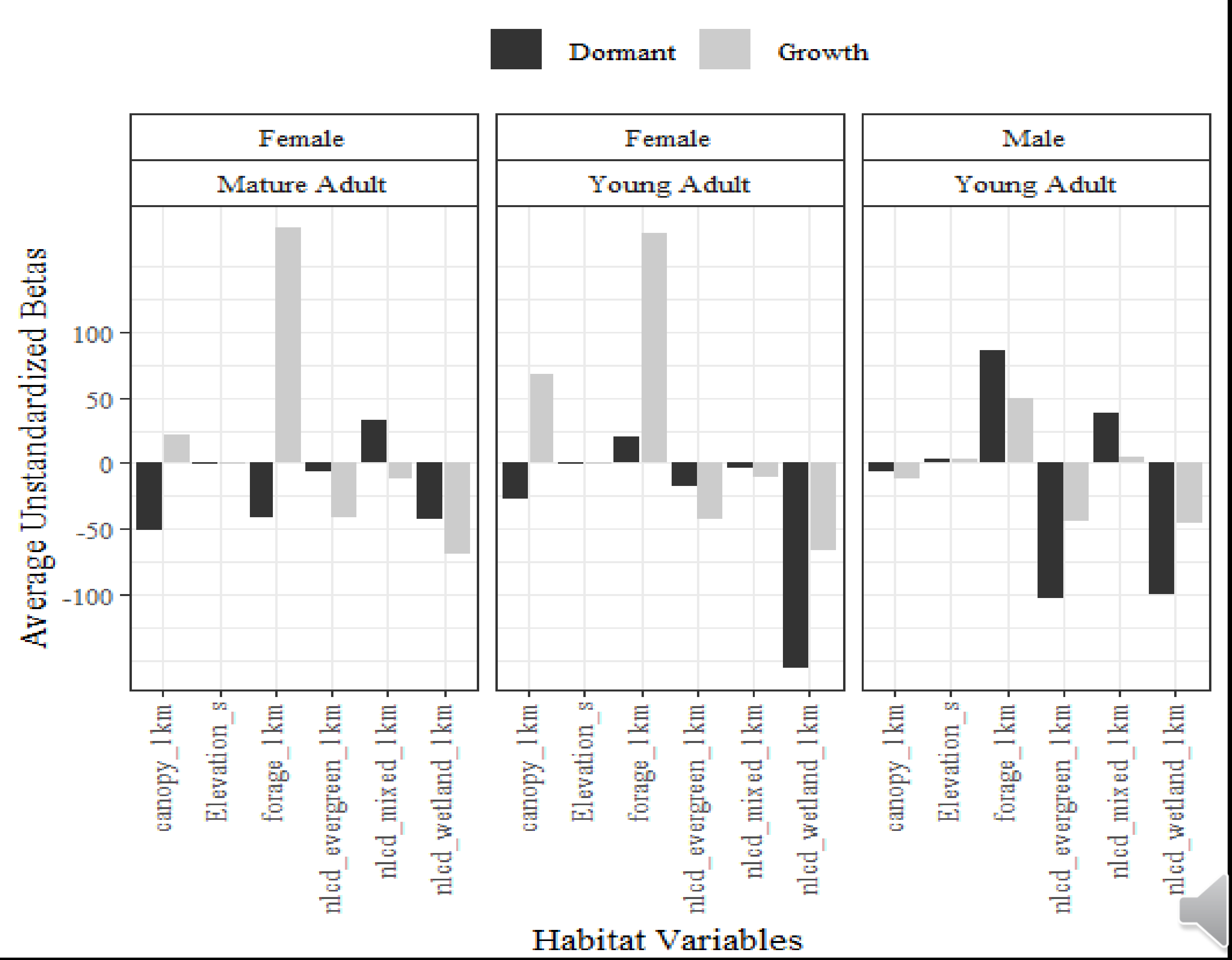


Objective 2 – Map suitability across the study area

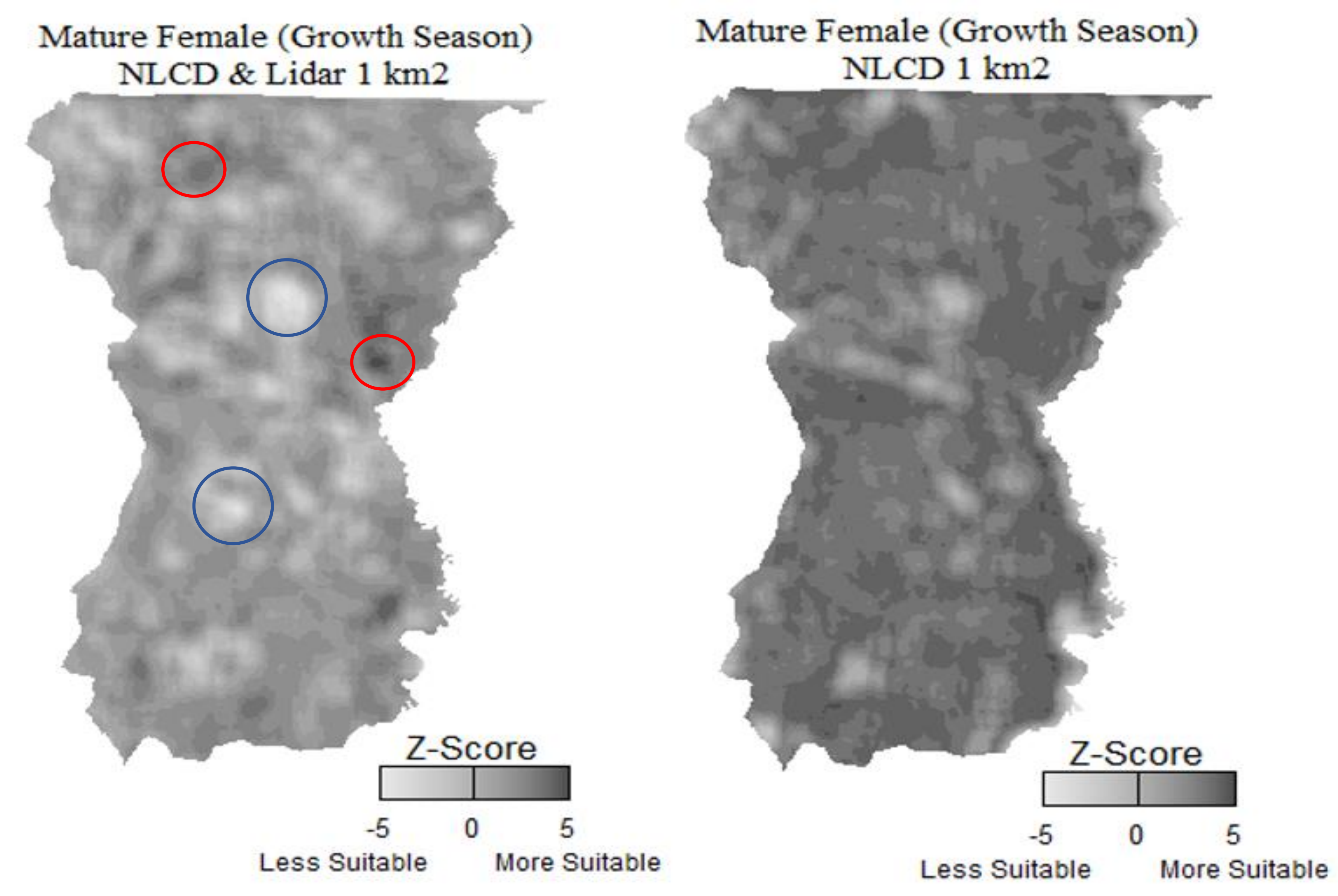
Methods

- Coefficients from the top ranked RUF model were used to create habitat suitability maps

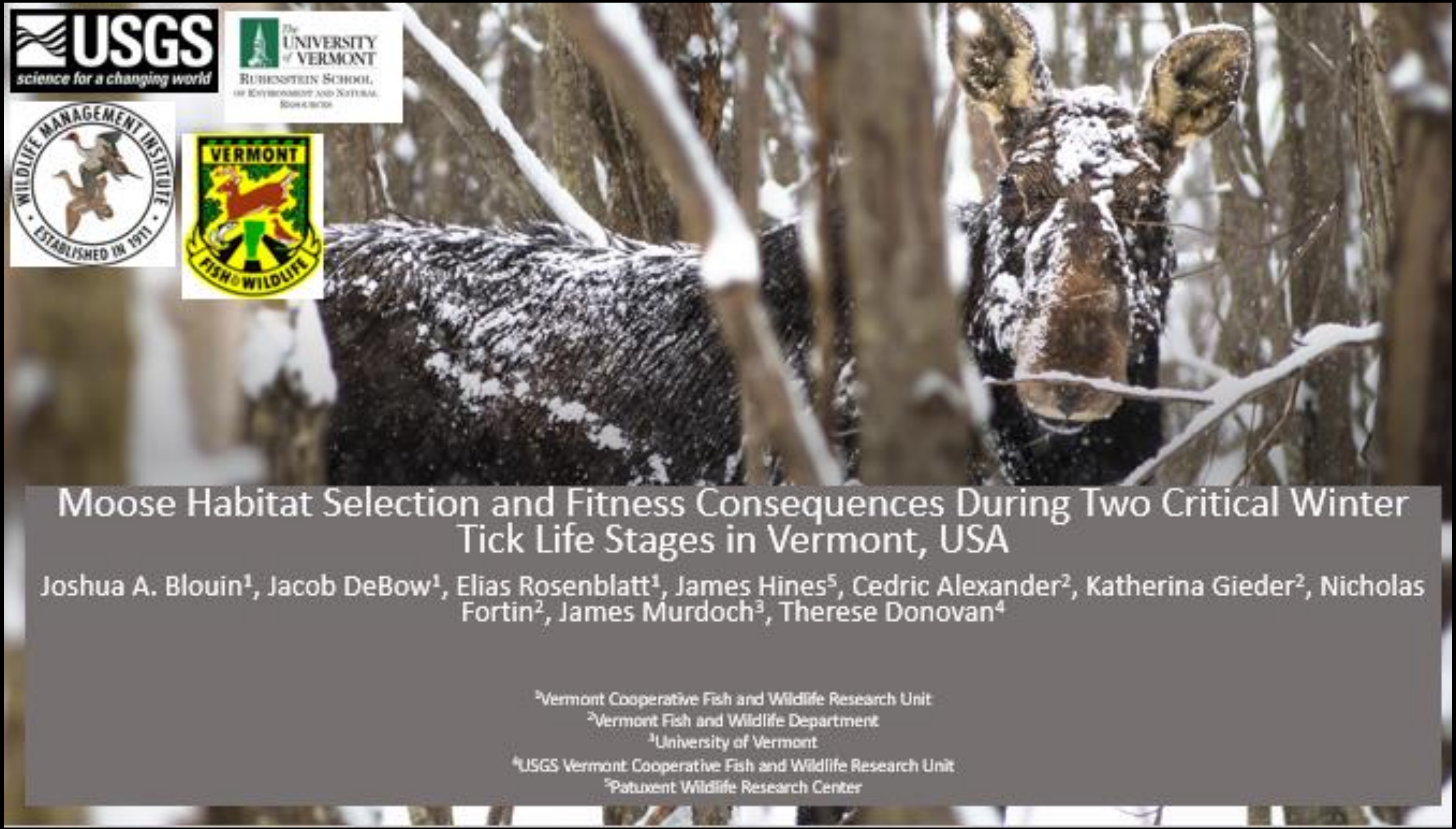
- Strength (height) and direction of the betas pull the suitability scores for each patch ($10m^2$) up or down depending on the habitat structure and composition of that patch



Mature Female HSI models



How does habitat selection relate to the tick issue?



Acknowledgments

Funding

- Vermont Fish & Wildlife Department
- USGS Vermont Cooperative Fish and Wildlife Research Unit
- USDA McIntire-Stennis Program
- Rubenstein School of Environment and Natural Resources

Supporting Organizations

- Silvio O. Conte National Fish and Wildlife Refuge
- VELCO
- NH Fish and Game
- Maine Department of Inland Fisheries and Wildlife

Special Thanks

- **Cedric Alexander**
- Mark Scott
- Nick Fortin
- Cheryl Sullivan
- Scott Darling
- Tony Smith
- Steve Agius
- Sean MacFaden