ASSESSING MOOSE (*ALCES ALCES*) POPULATION DEMOGRAPHICS IN NEW HAMPSHIRE, USA THROUGH CAMERA TRAP ANALYSIS

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INTRODUCTION

BACKGROUND

- Large ungulates have ecological, economic, and cultural importance.
- Sex ratio and productivity data are lacking due to low harvest limited validity from deer hunter surveys, yet these metrics are vital for effective management[1,2]

MOOSE IN NH

Populations are influenced by:
- Harvest (33 permits)[3]
- Habitat quality[4]
- Parasites/disease[5]
- Climate change[6]

OBJECTIVES

- Estimate moose **sex ratios**
- Assess moose productivity by estimating moose **calf:cow ratios**

METHODS

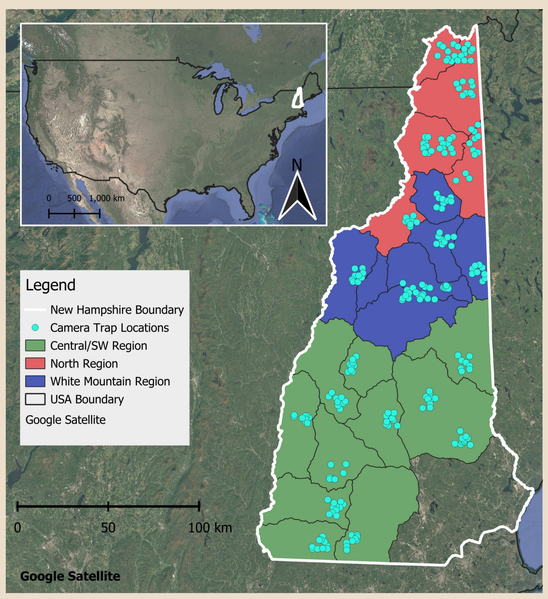


Figure 1: Camera trap locations (blue dots) in New Hampshire, USA, where images of moose were collected to estimate sex ratios and calf:cow ratios during the summer of 2022-2024.

CAMERA GRID DESIGN

Stratified camera trap grids based on key environmental moose population drivers
- Northern (logging activity)
- White Mountains (elevation)
- Central/Southwest (forest patch)

CAMERA DEPLOYMENT

- Motion triggered camera traps were deployed for **10 weeks (May – September)**
- Cameras took bursts of **8 images per trigger with a one-second delay**
- To enable density estimation, we set up detection triangles at every camera site

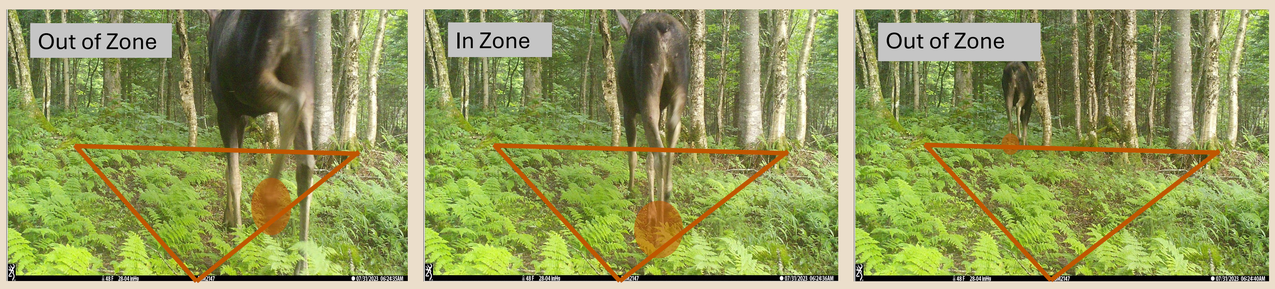


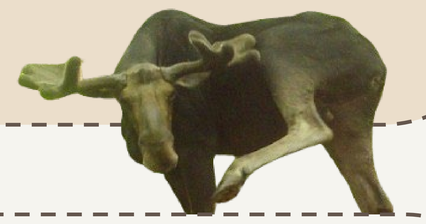
Figure 2: Camera trap images illustrating the defined detection zone (orange triangle) used in density estimation models. Only individuals with their rear back foot fully within the zone ("In Zone," center image) are included in density estimates. Moose partially or fully outside the zone ("Out of Zone," left and right) are excluded to ensure spatial consistency and model accuracy.

ANALYSIS

- We used the **Random Encounter and Staying Time (REST)** model

$$D = \frac{E(Y) \times E(T)}{sH}$$

- D = population density
- E(Y) = estimated # of detections
- E(T) = estimated staying time
- S = detection zone
- H = research period



RESULTS

From 2022-2024, we collected **9,236 images** of moose within our detection zone at **81 different camera traps** during a total of **8,100 trap days**

Table 1: Estimated moose densities of bulls (>1 year old), cows (>1 year old), calves, sex ratios (bull:cow), and productivity ratios (calf:cow) from Bayesian camera trap models in New Hampshire, 2022–2024. Values are posterior means with 90% credible intervals.

	2022	2023	2024
BULL	0.35 *(0.25-0.56)*	0.23 *(0.12-0.40)*	0.24 *(0.14-0.38)*
COW	0.26 *(0.15-0.42)*	0.12 *(0.07-0.21)*	0.27 *(0.18-0.40)*
CALF	0.08 *(0.03-0.17)*	0.05 *(0.02-0.12)*	0.08 *(0.02-0.22)*

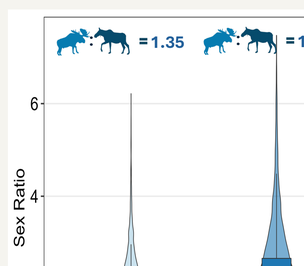


Figure 3: Posterior distributions of sex ratios (bull:cow), estimated using density estimates of all cows and cows with calves in New Hampshire, 2022-2024, from the REST model. Violin plots illustrate the density of simulated sex ratio values with overlaid boxplots indicating medians and interquartile ranges. The dashed green line at a 1:1 sex ratio marks parity.

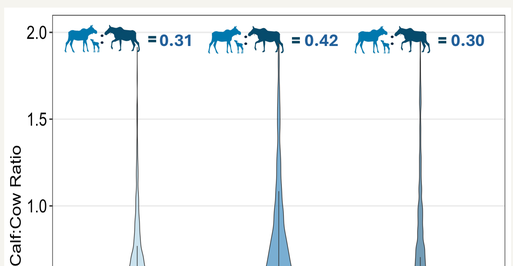


Figure 4: Posterior distributions of calf:cow ratios, estimated using density estimates of cows and cows with calves in New Hampshire, 2022-2024, from the REST model. Violin plots illustrate the distribution of simulated productivity ratio values with overlaid boxplots indicating medians and interquartile ranges. The dashed green line marks calf:cow ratio = 0.5, a reference threshold reported by Jones et al. (2017) for New Hampshire moose.

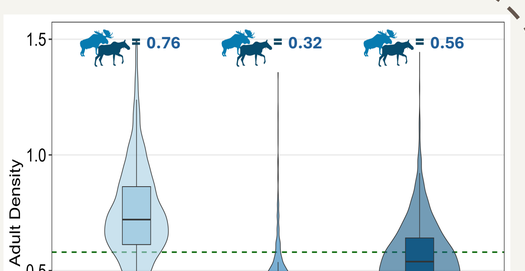
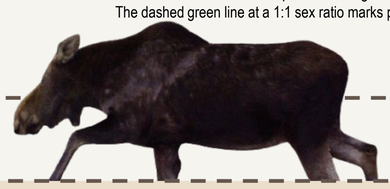


Figure 4: Posterior distributions of adult densities for 2022-2024, estimated using density estimates of all adults in New Hampshire, 2022-2024, from the REST model. Violin plots illustrate the distribution of simulated density estimate values with overlaid boxplots indicating medians and interquartile ranges. The dashed green line marks adult density = 0.58, a reference density.



DISCUSSION

SEX RATIOS

- **Male biased** in 2022 and 2023
- Shift toward **parity in 2024**

PRODUCTIVITY RATIOS

- Consistent with historical estimates (e.g., 0.39[7])
- Lower than recent estimates (e.g., 0.46-0.87[8]), indicating **reduced yearling productivity**

CONTRIBUTING FACTORS

- Poor calf **recruitment,** likely due to tick parasitism
- **Winter tick** parasitism may be causing a higher mortality in female calves than male calves[8]

MANAGEMENT IMPLICATIONS

- **Reducing** local moose densities or using forest management to **disperse forage** may reduce winter ticks drop off in spring and larval questing habitat use overlap[2]

ACKNOWLEDGEMENTS

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1. Rines 2015 *NHF&G*, 2. Jones et al. 2017 *Alces*, 3. Jones 2024 NHF&G, 4. Moen et al. 1998 *Ecosyst.*, 5. Murray et al. 2006 *Wildl. Monogr.*, 6. Jones et al. 2019 *Can. J. Zool.*, 7. Bontaites & Gustafson 1993 *Alces*, 8. Ellingwood 2018 UNH