

# Adaptive broad-scale movements of boreal caribou in response to insect outbreaks

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## Context

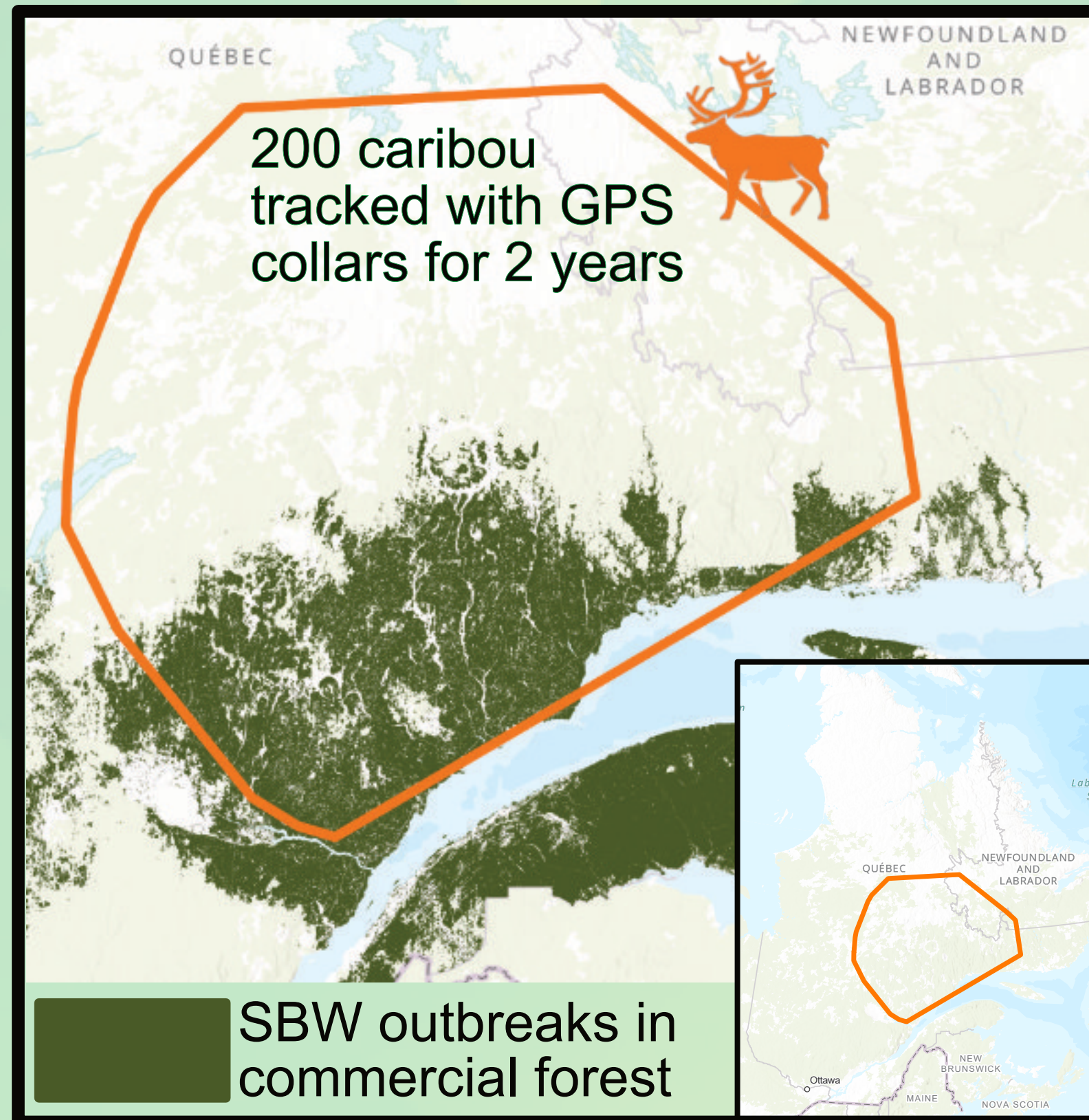
The boreal caribou (*Rangifer tarandus caribou*) is a threatened ungulate found across Canada's boreal forests! A major threat to its survival is increased apparent competition with moose (*Alces alces*), which arises through shared predation by gray wolves (*Canis lupus*) - a dynamic intensified by forest disturbances.<sup>2</sup> While the impacts of fire and logging on this system have been well studied, insect outbreaks, such as those caused by the spruce budworm (SBW), have received far less attention. This is despite SBW outbreaks affecting much larger areas<sup>3</sup> and altering both lichen biomass consumed by caribou and deciduous browse eaten by moose.<sup>4</sup>

## Objectives

- Assess how variations in food biomass for moose and boreal caribou, along with the severity of spruce budworm (SBW) outbreaks, influence home-range fidelity in caribou.
- Evaluate whether consequent broad-scale movements serve as an adaptive strategy to reduce mortality risk.

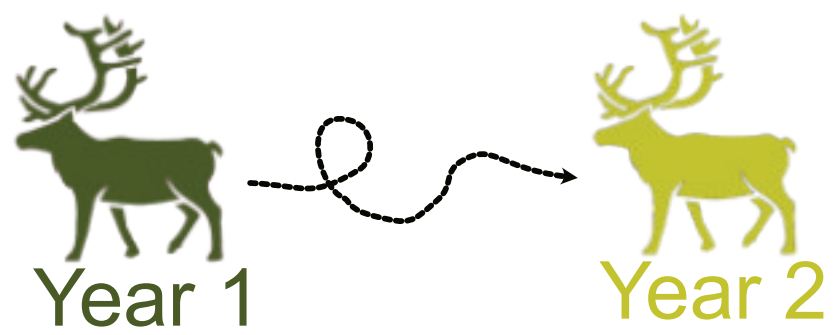
## Methods

- Land cover & forest types** from satellite imagery.<sup>5</sup>
- Lichen & browse biomass** field-calibrated by cover type.
- SBW outbreak severity** index from aerial photographs.<sup>6</sup>
- Mortality:** Pairing 100 deceased with 100 surviving caribou.
- Annual habitat use and availability :**
  - within the home range;
  - surrounding the home range;
  - in the landscape (i.e., surrounding the home range of the previous year).
- Annual habitat selection** from observed vs. random locations at two scales (within the home range and in the landscape).

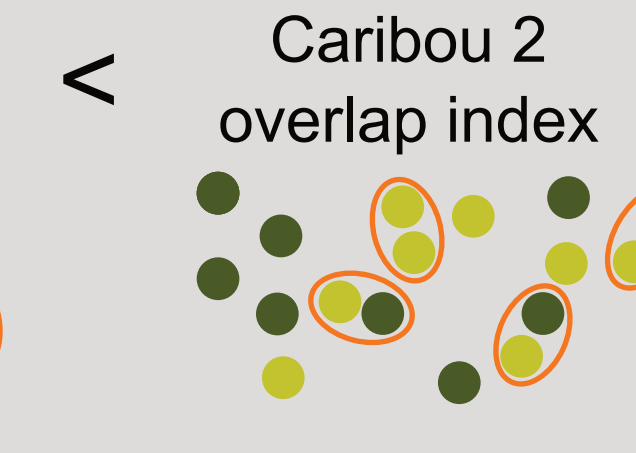
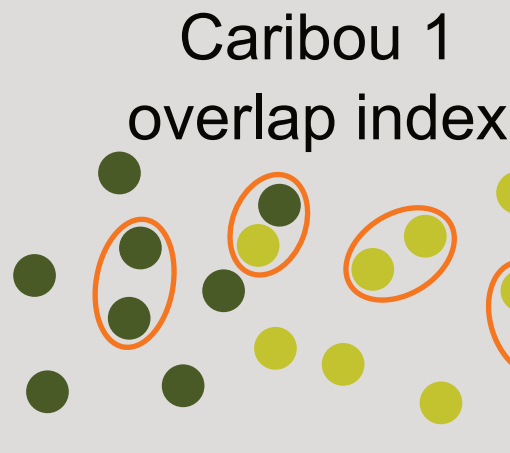
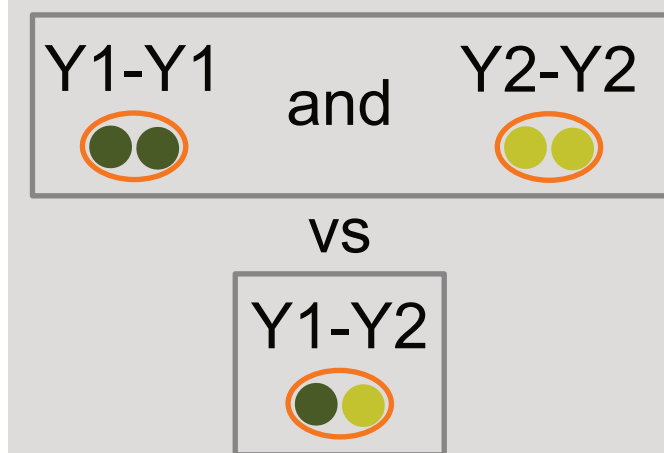


## Site fidelity indices

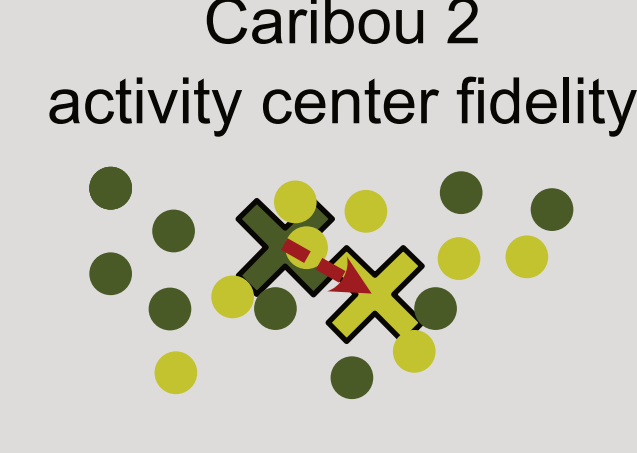
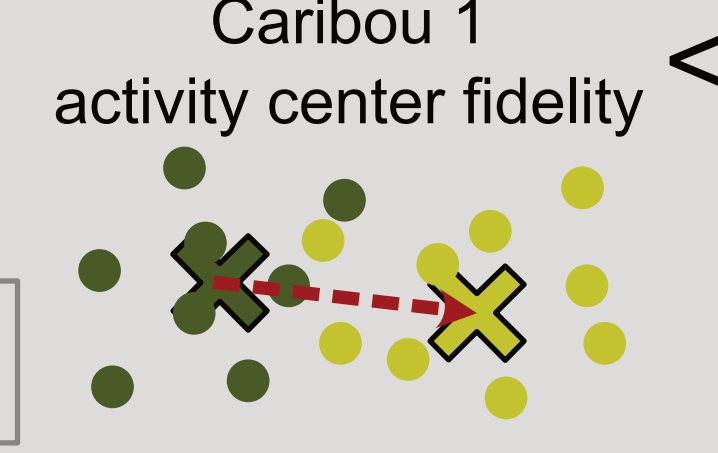
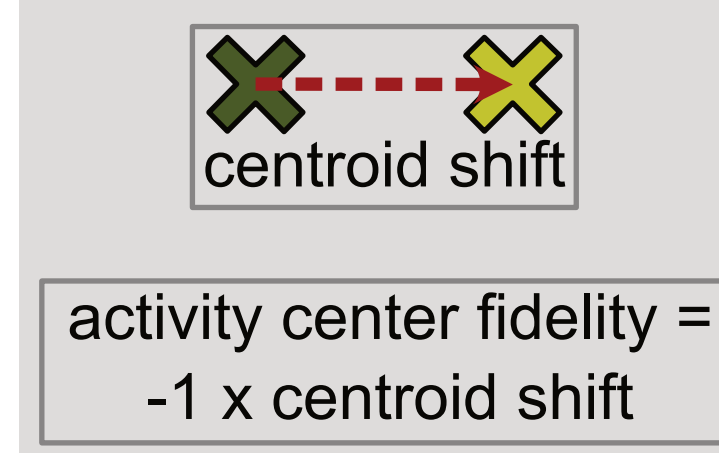
Based on two consecutive years of locations from the same caribou.



### Overlap fidelity index<sup>7</sup>



### Activity center fidelity



## Results

### Step 1: Site fidelity determinants

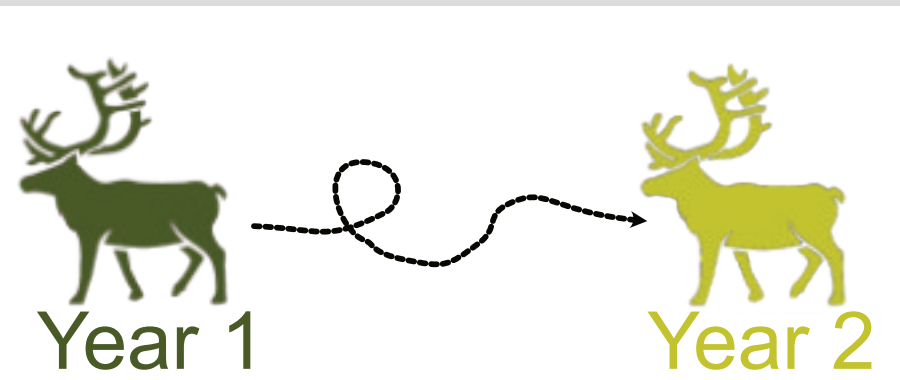
- Lichen and browse biomass surrounding the home range had a negative effect on site fidelity.
- An increase in browse biomass or SBW severity within the home range was associated with decreased site fidelity.



### Habitat features in year 1

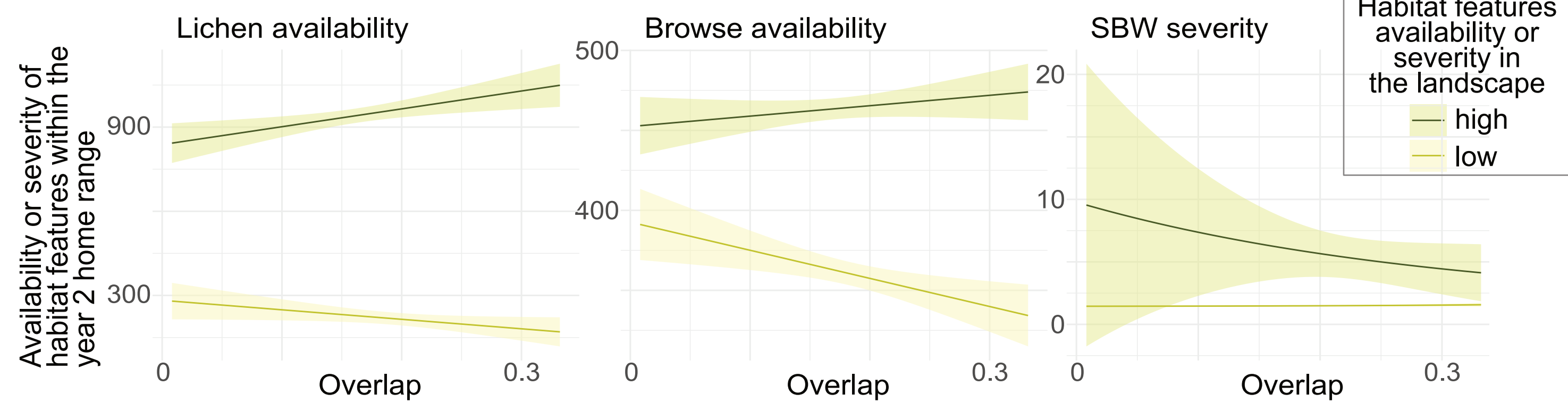
- Surrounding the home range
- Changes during the year
  - Lichen biomass
  - Browse biomass
  - SBW severity

### Site Fidelity



### Step 2: Determinants of Year 2 habitat features

- When lichen or browse availability was low in the landscape, site fidelity was associated with a decrease in the availability of these resources (lichen or browse, respectively) within the year 2 home range. Conversely, in landscapes with high availability of lichen or browse, site fidelity corresponded to an increase in these resources.
- Under conditions of high spruce budworm (SBW) severity across the landscape, site fidelity appeared to be an effective strategy for selecting a home range less impacted by SBW in the subsequent year.



### Habitat features in the year 2 home range



### Habitat features in the landscape

### Step 3: Mortality determinants

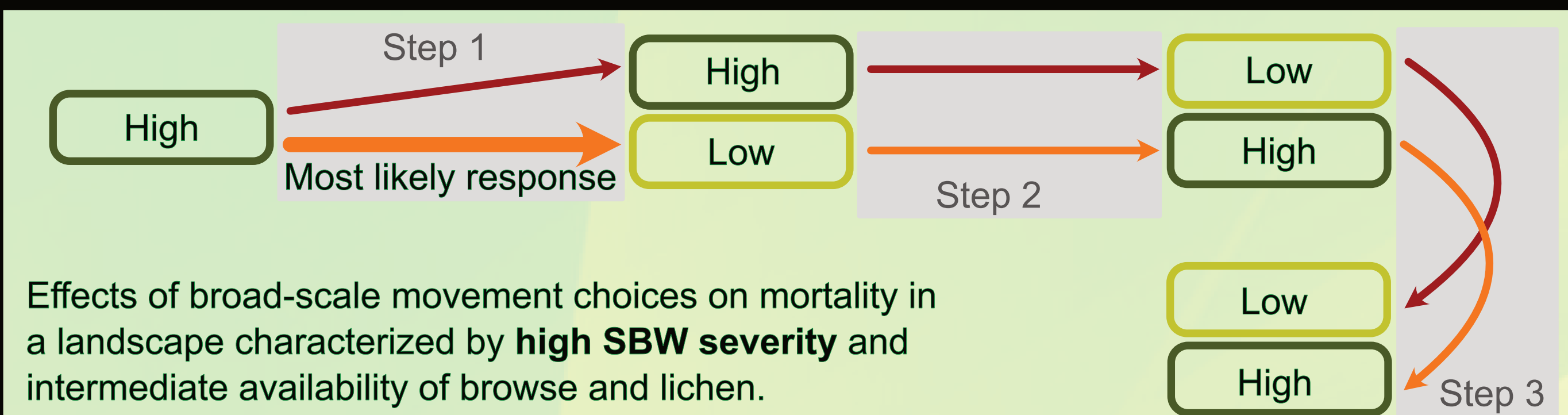
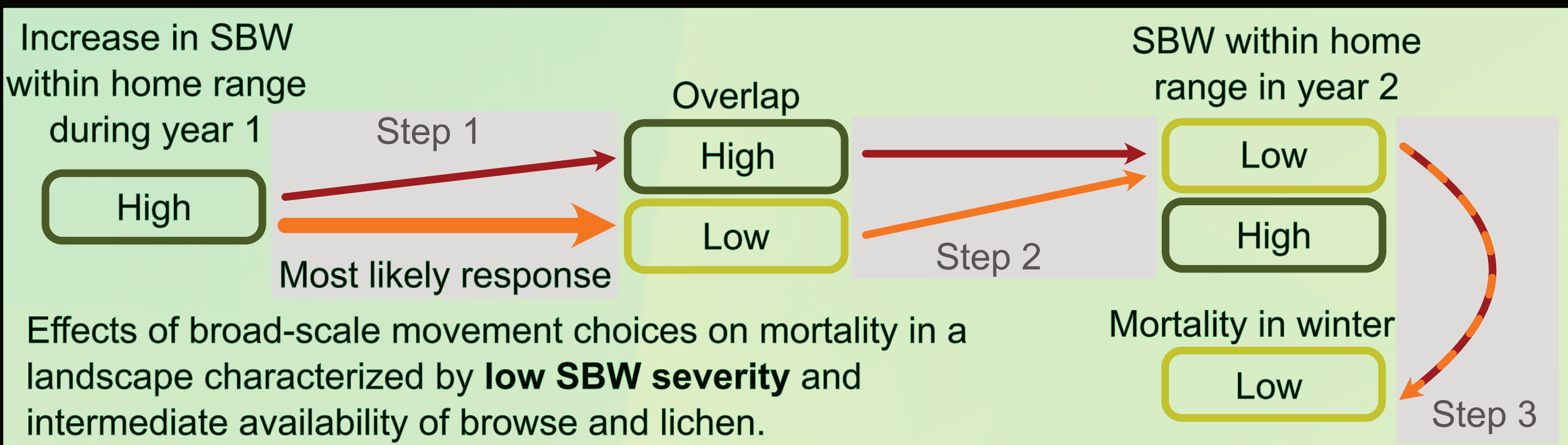
- No direct effect of site fidelity.
- Increased availability and selection of browse within the year 2 home range were associated with higher mortality.
- SBW severity in the year 2 home range contributed to higher mortality during winter.

### Habitat selection within home range

### Mortality



## Example of inferences from a Conditional Process Analysis<sup>8</sup> combining three modeling steps



## Conclusion

- High availability of lichen and browse within the home range was associated with reduced site fidelity. In contrast, an increase in browse availability or SBW severity over the course of the year was linked to a decline in site fidelity.
- Broad-scale movements induced by site fidelity, as a strategy for modifying food availability and SBW severity in the home range, indirectly affected survival.
- In landscapes extensively impacted by SBW outbreaks, enhanced site fidelity appears to represent an adaptive strategy for caribou. However, increasing SBW severity within the home range was associated with reduced site fidelity, potentially compromising this adaptive response.

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## Acknowledgements

