Are plant – ungulates interactions related to climate?

Comparison of consumption indexes along elevation gradients across a latitudinal gradient of European sites

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Increase in deer population + spatial expansion
• Climate change

What future for tree species of economic interest?
→ Mixed forests = strategy to adapt to global changes
At a biogeographic scale:

- How does browsing vary with climate?
- Is browsing more critical than climate for seedling growth?
Study sites along a European latitudinal gradient, each one containing an altitudinal gradient.

Climatic data: WorldClim database, downscaled at each plot by altitude. Only the temperature was kept for the analysis.
For each tree species, 20 seedlings randomly chosen per elevation.

Measurements:

- Height
- Browsing (B = 0 or B = 1)
• How does browsing vary with climate?

2 variables used, for each tree species, site and elevation:

- Browsing ratio = \( \frac{\text{Nb seedlings \textit{browsed}}}{\text{Nb seedlings \textit{available}}} \)

- “Browsing” = data measured on the field:
  - \( B = 0 \) → unbrowsed seedling
  - \( B = 1 \) → browsed seedling
• How does browsing vary with climate?

Norway spruce = the least browsed species. Browsing ratio \(\downarrow\) with temperature, \(\neq\) slopes between tree species.
Different palatabilities of tree species:

- Sycamore maple
- Common beech
- Silver fir
- Norway spruce

Classification of \{ Site\_Elevation \} according to their contribution to browsing.

Generalized mixed model, with a binomial family:

\[
\text{Browsing} \sim \alpha + \beta_1 \times \text{Species} + \beta_2 \times \{ \text{Site\_Elevation} \}
\]
- How does browsing vary with climate?

Browsing ~ \( \alpha + \beta_1 \times \text{Species} + \beta_2 \times \{ \text{Site} - \text{Elevation} \} \)
How does browsing vary with climate?

Climate does not obviously explain this “β₂ classification” (~ increasing browsing intensity)
How does browsing vary with climate?

Browsing ~ \( \alpha + \beta_1 \times \text{Species} + \beta_2 \times \{\text{Site} - \text{Elevation}\} \)

\( \beta_2 \) marginally decreases with temperature (\( p = 0.06 \))
How does browsing vary with climate?

- Broadleaved trees are preferred to coniferous. Boulanger et al., 2009
- Silver fir remains preferred to Norway spruce. Bernard et al., 2017
- Browsing marginally decreases with temperature. Rasmann et al., 2014
- No clear trend → climate is not sufficient to explain browsing.
• How does browsing vary with climate?

✓ Broadleaved trees are preferred to coniferous. Boulanger et al., 2009
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• Is browsing more critical than climate for seedling growth?

→ Focus on:
  - mean late spring temperature (April – May – June)
  - silver fir seedlings
Browsed seedlings are significantly taller than unbrowsed ones. Silver fir seedlings < 10 cm seem to be barely eaten.

Is browsing more critical than climate for seedling growth?
The height of silver fir seedlings increases with temperature.

- Is browsing more critical than climate for seedling growth?
The height of silver fir seedlings increases with temperature, but not for browsed seedlings.
How does browsing vary with climate?

- Broadleaved trees are preferred to coniferous. Boulanger et al., 2009
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- No clear trend \(\rightarrow\) climate is not sufficient to explain browsing.

Is browsing more critical than climate for seedling growth?

- Browsed seedlings are taller, except for Norway spruce. Taylor et al., 1999; Taylor et al., 2001; Diaci et al., 2002; Bergquist et al., 1998
- Seedlings height increases with temperature. + Oleksyn et al. 1998, Leites et al., 2012, Way et al., 2010; - : Olszyk et al., 1998, Jump et al., 2006
Assumptions:

- Beech preferred to silver fir: confusion between browsing and frost damage?
- Browsing would decrease with temperature due to more herbaceous vegetation.
- Winter snow cover would only allow browsing of taller seedlings.
- There might be a thermic threshold under which seedling height is a cause of browsing, and over which it becomes a consequence.
- Ungulate pressure locally influences seedling height more than temperature does.
- The thermic gradient may thus be biased by a herbivory gradient.
Browsing by ungulates interacts with temperature to explain seedling growth
Browsing by ungulates interacts with temperature to explain seedling growth

Difficult to complete an existent dataset with additional data such as ungulate pressure

Need to assess ung. pressure when settling large monitoring networks, gradients.
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