XV WORLD FORESTRY CONGRESS
Building a Green, Healthy and Resilient Future with Forests
2–6 May 2022 | Coex, Seoul, Republic of Korea

Mid-term demographic dynamics in stem exclusion stage of beech forest in Ulleungdo island, South Korea

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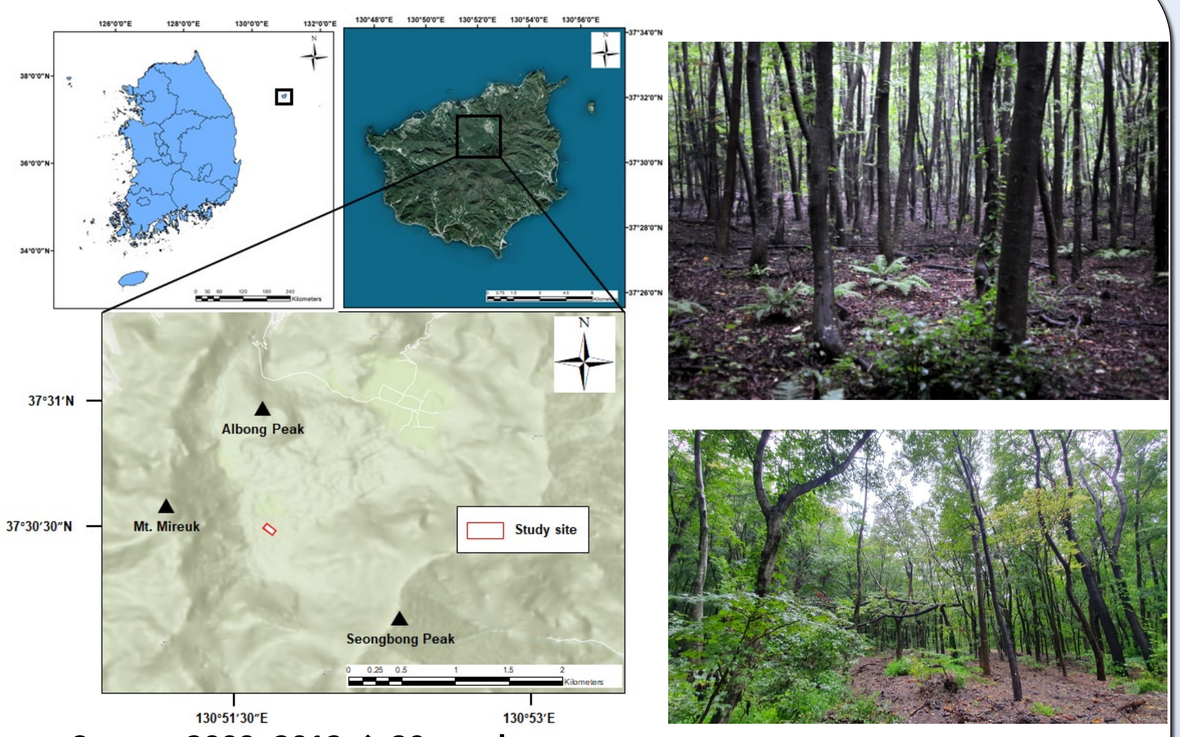
Introduction

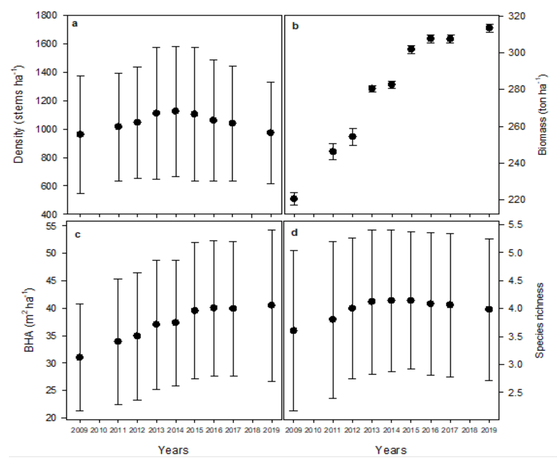
- Monitoring the process of changes in species composition and structure during forest successional development is key to understanding changes in ecosystem function (Noss 1990, Spellerberg 2005, Ediriweera et al. 2020).
- Tree communities in forests contain most of the ecosystem's carbon stock, and changes in tree community composition with forest development are key determinants of understory biodiversity (Franklin et al 2002, Lutz & Halpern 2006).
- In particular, the process of tree community development after anthropogenic or natural disturbance is a spatiotemporal laboratory essential for a clear understanding of key ecological processes and stages, which provides ecological knowledge necessary for species and forest restoration and management (Halpern & Lutz, 2013).
- The species composition of local communities at ecological time scales is influenced by deterministic and stochastic processes.
- Both ecological processes operate concurrently and their relative importance is generally affected by the environmental context and the state of community development (e.g., forest age).
- Demographic dynamics, resulting from recruitment, growth and death in a tree community are a lengthy process.
- The stem exclusion stage is a stage of forest development important for understanding the patterns of change in tree demographic rates, especially regarding density and its subsequent effects on forest functions (e.g., biomass and diversity) (Moridi et al. 2015).

Methods & Materials

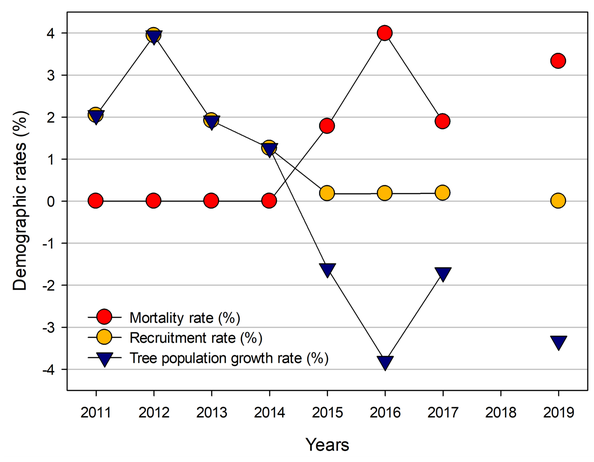


- Survey: 2009~2012 → 20 quadrats
  2013~2019 → expanded the plot to a size of 0.5 ha by adding 30 quadrats to the initial plot
  Annual monitoring of the development process of *Fagus engleriana* dominated young deciduous broad-leaved forest
- Data: Measured the diameter at breast height (DBH) of each tree (DBH ≥ 2.5 cm)
- Analysis: Estimated by measuring the quadrat-level mean stem density (stems ha^{-1}) and mean breast height area (BHA) ($m^2\ ha^{-1}$).

Results



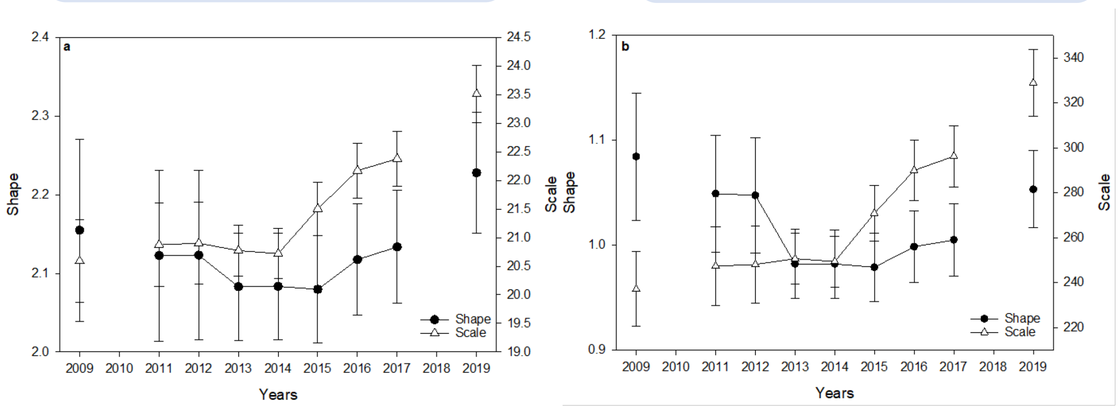
Changes in Community structure and function (Density, Biomass, BHA, Species richness)



Changes in demographic rates (Growth rate, Recruitment rate, Mortality rate)

- ✓ Density: bell-shaped curve
- ✓ Biomass: Sigmoidal pattern
- ✓ SR: Not significantly change

- ✓ Dramatic shift and uncertainty in forest development



Distribution shape and scale parameters of the DBH (a) and biomass (b)

- ✓ DBH- Shape/Scale: exponential distribution → normal distribution
- ✓ Biomass- Shape/Scale: similar tendency to diameter distribution (single peak → multi-peak)

Discussion

Structural and functional forest dynamics

- The distribution of tree size is an attribute arising to demographic rates that can be estimated from tree population growth rate, mortality rate and recruitment rate.
- Differential mortality of species with various traits (e.g., shade tolerance) and sizes also influences the pattern of diversity and compositional change.

Demographic dynamics and forest development

- In forest development stages including the stem exclusion stage, Suppression accounts for most of the causes of death in individuals.
- Mortality is closely related to the demographic perspective (e.g., individuals and biomass).
- The occurrence of a forest gap in a young forest leads to changes in the surface environment, promoting the development of understory vegetation, and the recruitment of individuals.

Conclusion

- There is a dramatic shift between the recruitment and mortality rates in the stem exclusion stage, and that disturbance increases the uncertainty in forest development increases by stochastic soil deposition disturbance.
- Our midterm records of ecological succession exhibited detailed demographic dynamics and contributed to the improvement of an ecological perspective in the stem exclusion stage.

Acknowledgement

This study was carried out with the support of 'R&D Program for Forest Science Technology (Project No. "2019150C10-2123-0301"&"2021346B10-2123-CD01")' provided by Korea Forest Service(Korea Forestry Promotion Institute) and 'Research Program ("KNA 1-2-26, 16-4"&"KNA 1-2-32, 18-3") of the Korea National Arboretum.