

1. PHD PROJECT DESCRIPTION (4000 characters max., including the aims and work plan)

Project title:

Links between site index of Scots pine (*Pinus sylvestris*) stands and environmental variables

1.1. Project goals

The main goal of the project is to evaluate the effect of soil properties and plant species richness on site index of Scots pine stands, taking into account also climate and vegetation characteristics.

The specific project goals are as follows:

- To evaluate the effect of soil properties (pH; stocks of C, N, Ca, Mg, K; content of textural classes) on site index of Scots pine stands.
- To evaluate the relationship between plant species richness (total richness in a plot as well as the richness occurring in particular forest strata) and site index of Scots pine stands.
- To recognize links between pine stand productivity and vegetation characteristics - plant leaf and stem traits (e.g. specific leaf area - SLA, leaf dry mass content – LDMC, plant height) as well as the Ellenberg-type indices (e.g. Tichy et al. 2022).
- To evaluate the effect of climatic characteristics (temperature and precipitation variables, Standardised Precipitation-Evapotranspiration Index – SPEI etc.) on pine stands productivity.
- To elaborate models (including pedogenic, vegetational and climatic characteristics) describing importance of particular variables on site index of Scots pine stands.

1.2. Outline

Scots pine (*Pinus sylvestris*) is the main tree species in extensive areas of Central European lowland forests. However, until now, environmental agents affecting productivity of the stands have not been recognized in detail. The commonly used indicator of forest productivity is “site index” based on tree height (e.g. Skovsgaard & Vanclay 2008). Effects of soil properties on the site index of Scots pine stands have been lately recognized (Sewerniak 2011, 2012a,b), however, this research referred only to three forest districts located in south-western Poland. In turn, in recent studies the links between forest productivity and plant species richness of a forest stand have been increasingly highlighted in literature. Namely, it was revealed that the richness is strongly positively related to the forest productivity (Zhang et al. 2012; Liang et al. 2016). This relationship was also revealed directly to Scots pine stands in Central Europe (Sewerniak 2020). Although this study was conducted in 129 plots only, the results suggested that species richness of vascular plants can be more important for productivity of temperate pine forests than soil fertility. The previous research investigated quantitative effect of a vegetational agent (number of species) on forest stand productivity (Liang et al. 2016; Sewerniak 2020). In turn, plant functional traits and ecological Ellenberg-type indices, which reflect strongly site environmental conditions (Sewerniak & Puchałka 2020; Puchałka et al. 2023), until now have not been investigated as potential indicators of pine stands productivity in European temperate forests.

Until now, the complex analysis investigating jointly effects of pedogenic, vegetational and climatic agents on the productivity of Scots pine stands in Central Europe has not been conducted, which will be done in the proposed project. This will be feasible due to the utilization wide data set (almost thousand plots located in several dozen forest districts) gained from resources of the Polish State Forests, which contain all detail data regarding pedological and vegetational part of the study. Climatic variables necessary for the project will be gained from e.g. the WorldClim database (Fick & Hijmans 2017).

1.3. Work plan

The project will be realized from 2024 to 2028. The estimated terms of the main project tasks are as follows:

- Literature studies (2024-2027),
- Gathering data from resources of Polish State Forests (2024-2025),
- Gathering climatic data and plant traits/indices from internet free databases (2024-2026),
- Preparing own database based on the gained records (2025-2027),
- Analyses of the results and elaboration of statistical models (2026-2027),
- Presentation of the results and writing PhD thesis (2026-28).

1.4. Literature (max. 10 listed, as a suggestion for a PhD candidate)

- Fick S.E., Hijmans R.J., 2017. WorldClim 2: New 1-km Spatial Resolution Climate Surfaces for Global Land Areas. *International Journal of Climatology*, 37, 4302-4315. <https://doi.org/10.1002/joc.5086>
- Liang J., Crowther T.W., Picard N., 2016. Positive biodiversity-productivity relationship predominant in global forests. *Science* 354(6309). <https://doi.org/10.1126/science.aaf8957>
- Puchałka R. et al., 2023. Predicted range shifts of alien tree species in Europe. *Agricultural and Forest Meteorology* 341, 109650. <https://doi.org/10.1016/j.agrformet.2023.109650>
- Sewerniak P., 2011. The influence of soil texture on site index of Scots pine stands in south-west Poland. *Forest Research Papers* 72: 311-319. <https://doi:10.2478/v10111-011-0031-8>
- Sewerniak P., 2012a. Impact of soil properties on site index class of Scots pine (*Pinus sylvestris* L.) stands in south-western Poland. I. pH, content of CaCO₃ and properties concerning soil depth. *Sylwan* 156: 427-436. <https://doi.org/10.26202/sylwan.2012025>
- Sewerniak P., 2012b. Impact of soil properties on site index class of Scots pine (*Pinus sylvestris* L.) stands in south-western Poland. II. Some chemical properties. *Sylwan* 156: 518-525. <https://doi.org/10.26202/sylwan.2012026>
- Sewerniak P., Puchałka R., 2020. Topographically induced variation of microclimatic and soil conditions drives ground vegetation diversity in managed Scots pine stands on inland dunes. *Agricultural and Forest Meteorology* 291, 108054. <https://doi.org/10.1016/j.agrformet.2020.108054>
- Skovsgaard J.P., Vanclay J.K., 2008. Forest site productivity: a review of the evolution of dendrometric concepts for even-aged stands. *Forestry* 81: 13-31.

<https://doi:10.1093/forestry/cpm041>

- Tichy L. et al., 2022. Ellenberg-type indicator values for European vascular plant species. *Journal of Vegetation Science* 34:e13168. <https://doi.org/10.1111/jvs.13168>
- Zhang Y., Chen H.Y.H., Reich P.B., 2012. Forest productivity increases with evenness, species richness and trait variation: a global meta-analysis. *Journal of Ecology* 100: 742-749. <https://doi:10.1111/j.1365-2745.2011.01944.x>

1.5. Required initial knowledge and skills of the PhD candidate

A candidate should have basic knowledge on functioning of forest ecosystems, especially in the field of pedology and botany. Additionally, the following skills are required:

- ability for individually traveling and gaining data from units of the Polish State Forests in different parts of Poland (a driving licence recommended),
- ability of analytical analysis and interpretation of scientific results,
- basic knowledge and skills in the field of statistical analysis of the scientific results,
- ability to use graphic software,
- ability to efficiently work alone as well as in a team,
- communicative Polish and English.

1.6. Expected development of the PhD candidate's knowledge and skills

- expanded knowledge on the functioning of Scots pine stands, especially with regard to environmental agents affecting the stands productivity,
- ability to efficiently contact workers of the Polish State Forests to gain data from resources of the company,
- ability to form and analyse big databases,
- statistical analyse of the obtained results,
- introducing the results in presentations, as well as in a text form.