Excursion Report

08.05.2025 – 17.05.2025

Technical University Munich TUM

School of Life Sciences

Yale University

School of Forestry and Environmental Studies

Author: Klara Voggeneder (03791991)

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Supervisors: Klaus Pukall, Peter Annighöfer

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1. Introduction

Between the 8th and the 15th of May, 2025 a joint group of students and lecturers from the Technical University of Munich TUM in Weihenstephan, Freising, Germany and the Forest school of the Yale School of the Environment in New Haven, Connecticut, U.S. embarked on a 10-day excursion to visit a diverse set of forest enterprises and cultural sites in Germany, the Czech Republic and Austria. The focus of the excursion was on practical aspects of forestry, especially silviculture, protective forest management, and timber harvesting techniques, as well as topics such as hunting, agroforestry and nature conflicts. A second aspect was experiencing and understanding the balance between nature and human activities through visits to natural forest areas such as the Bavarian Forest National Park, state breweries (České Budějovice) and wineries (Weingut Geyerhof), and historical sites such as the city of Salzburg and the gothic carved altar in the town of Kefermarkt. During the excursion, the topics addressed were analyzed against the background of forest science and (forest) ecological theories and research approaches, critically examining the different histories and circumstances in Germany, Austria, and North America. Local stakeholders presented their perception of the diverse challenges of forest management and related topics such as environmental and nature conservation policy and their approaches to solving them. Input from the participating TUM and Yale lecturers and joint reflections by the students under the guidance of the lecturers in daily debriefings allowed for in-depth discussion of the topics and open questions.

For an overview, the excursion stops are visualized in the form of a map in Figure 1. The enterprises visited and their key characteristics regarding location, climate, ecology and management are presented in Table 1, allowing for quick comparison. For clarity, tree species mentioned in the excursion report are listed in Chapter 2 with their Latin, English and German name. This is followed by a brief recap of the excursion days in Chapter 3 and concluding remarks and a short dive into changing forest disturbances regimes in Europe under climate change in Chapter 4.

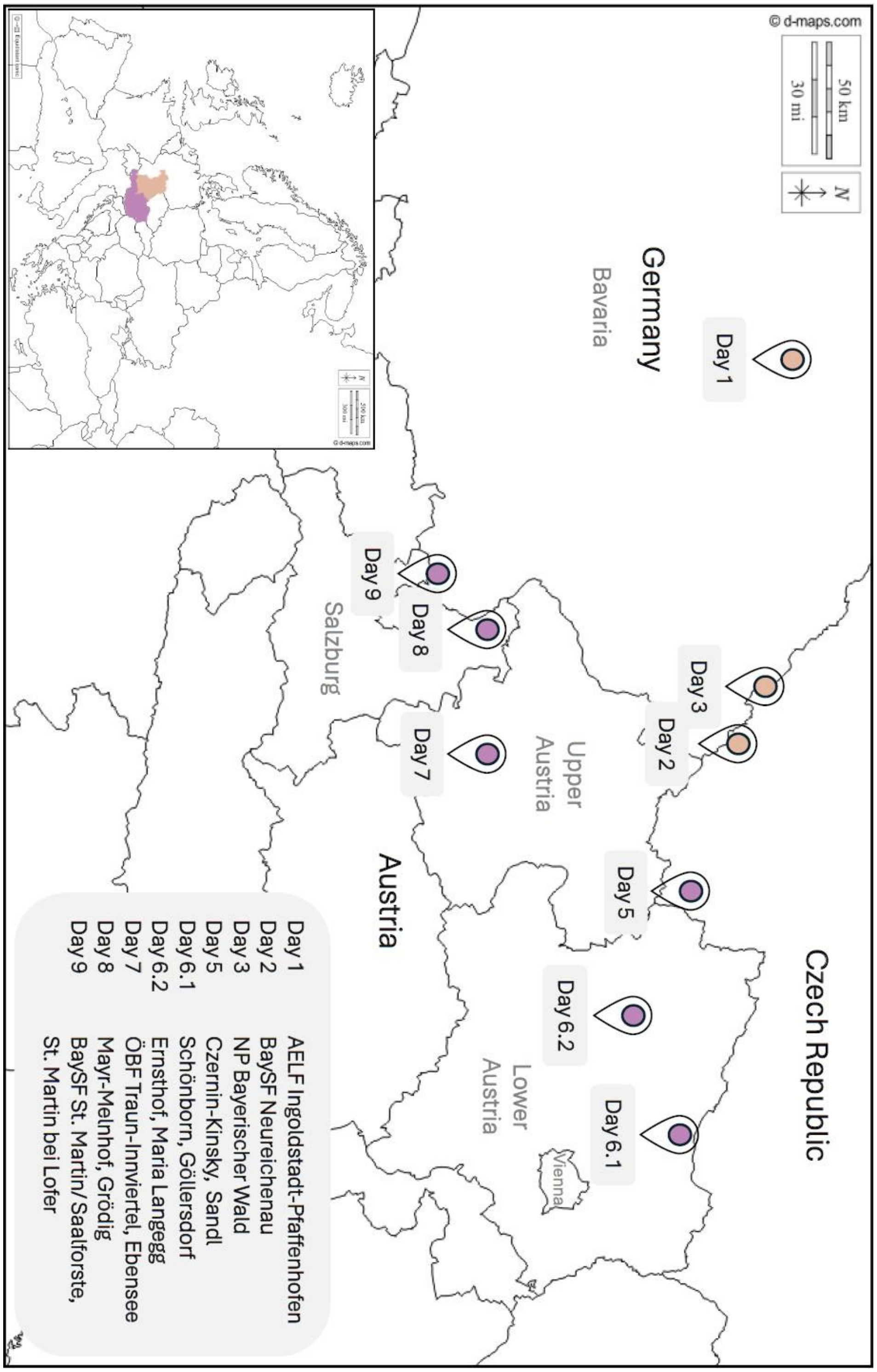

Figure 1: Excursion stops. Map visualizing the location of the forest enterprises visited throughout the excursion. Names of the enterprises are listed in the grey box in the lower right corner (Note: Day 4 was dedicated to cultural visits). An overview map of Europe can be found in the lower left corner with Bavaria (orange) and Austria (purple) being highlighted. Map adapted from d-maps.com

2. Enterprise overview

Day	1	2	3	5	6.1	6.2	7	8	9
Date	08.05.2025	09.05.2025	10.05.2025	12.05.2025	13.05.2025	13.05.2025	14.05.2025	15.05.2025	16.05.2025
Company	**Forest service Ingoldstadt – Pfaffenhofen**	**Bavarian State Forest enterprise Neureichenau**	**National park Bayerischer Wald / Sumava**	**Forest enterprise Czernin-Kinsky Forstgut Rosenhof**	**Forest enterprise Forst- und Gutsverwaltung Schönborn**	**Forest enterprise Forstverwaltung Ernsthof**	**Austrian State forest enterprise ÖBF Traun-Innviertel**	**Forest enterprise Mayr-Melnhof, Untersberg District**	**Bavarian State Forest enterprise Saalforsten**
Location	85110 Kipfenberg, Bavaria, Germany	94089 Neureichenau, Bavaria, Germany	94481 Grafenau, Bavaria, Germany / 385 01 Vimperk, Bohemia, Czech Republic	4251 Sandl, Upper Austria, Austria	2031 Göllersdorf, Lower Austria, Austria	4150 Maria Langegg, Lower Austria, Austria	4802 Ebensee, Upper Austria, Austria	5082 Grödig, Salzburg, Austria	5092 St. Martin bei Lofer, Salzburg, Austria
Ownership type	Municipal forest	State forest	State owned (Bavaria / Czech Republic)	Private forest	Private forest	Private forest	State forest	Private forest	State forest
Guides	Martin Scholz, Thomas Mathes	Mr. Madl	Prof. Jörg Müller	-	Maier, Hochbichler, Schöfberger	Martin Exenberger	Laurenz Aschauer	Frank Diehl, Michael Mitter	Thomas Zanker
Elevation (a.s.l.)	378 m	~ 815 m	600 - 1456 m / 600 - 1378 m	~ 900 m	250 – 360 m	250 - 700	500 - 1500 m	430 - 1850 m	600 - 2600 m
Av. Temperature	~ 9 °C	6.5 – 9.1 °C	3.5 – 6.5 °C	~ 5 °C	~ 10 °C	~ 8.5 – 9°C	5 - 6 °C	4 - 5 °C	5 - 7 °C
Av. Precipitation	~ 1000 mm	880 - 1100 mm	1,000 - 1,600 mm	~ 950 mm	~ 630 mm	~850 - 1,000 mm	1000 - 1400 mm	1200 - 1700 mm	1800 - 2100 mm
Geology/ Soil types	Leptosols, Cambisols, Regosols	Gneisses and Granites; Eutric or Dystric Cambisols, Podzols	Granites and Gneisses; Dystric Cambisols, Podzols, Histosols	Granite; Dystric Cambisols	Wetterstein Limestone; Leptsols to Cambisols	Granulite and Gneis; Cambisols	Limestone; Leptosols to Cambisols	Limestone; Leptosols to Cambisols	Limestone; Leptosols to Cambisols
Forest area (ha)	580	18,000	Bay. Wald: 24,945 Sumava: 68,460	6,650	3,500	~ 640	38,800	1897	11,108
Species	Silver fir, Norway spruce, European beech, Sycamore maple, (Douglas fir, Western red cedar)	Norway spruce, Silver fir, European beech, other broadleaves	Norway spruce, European beech, Sycamore maple, Silver fir, European mountain ash, Scots pine, European larch, Birches, Willows, Alder	Norway spruce, Silver fir, European beech	Oaks (petrea, robur), Scots pine, Douglas fir, European larch, Hornbeam, Wild cherry, Walnut, Sycamore maple,…	European beech, Sessile oak, Sycamore maple, Wild cherry, European ash, Birch, European mountain ash	Silver fir, Norway spruce, European beech, (Sycamore maple, Wych elm, European mountain ash)	Norway spruce (69%), European larch (7%), Silver fir (2%), other conifers, European beech (12%), European Ash (1%), Alder (1%) and other broadleave species (7%)	Norway spruce (64%), European larch (11%), Silver fir (7%), Scots pine (2%), European beech (9%), others
Management goals	Timber production, forest stability and diversity	Timber production, close-to-nature forest management		Mass timber production	High value timber production	High value hardwood timber production	Timber production, Protection forests	Hunting and timber production	Timber production, Protection forests
Forest structure/ Management types		Irregular group shelterwood, group and single-tree selection systems	In the core zone: no managment, protection of natural processes	only natural regeneration (shelter wood system), low stem density spruce stands, age class system	Oak Hochwald (30%), Oak Coppice with Standards (22%), Scots pine, Douglas fir, European larch and other mixed forests	Permanent forest	Mountain forests	Spruce dominated mixed forests	32% Mountain forests (32%), Protection forests (68%)
Annual harvest	8.3 m^3 / ha	9 m^3 / ha		7.26 m^3 / ha		7.8 m^3 / ha		7.4 m^3 / ha	4.46 m^3 / ha

Table 1: Enterprise overview. Key characteristics/ figures of the enterprises visited during the excursion.

3. Species list

Latin Name	English Name	German Name
Abies alba	Silver fir	Weißtanne
Acer platanoides	Norway maple	Spitzahorn
Acer pseudoplatanus	Sycamore maple	Bergahorn
Alnus glutinosa	Black alder	Schwarzerle
Betula pendula	Silver birch	Hängebirke
Betula pubescens	Downy birch	Moorbirke
Carpinus betulus	European hornbeam	Hainbuche
Castanea sativa	Sweet / European chestnut	Edelkastanie
Corylus avellana	European hazel	Gemeine Hasel
Fagus sylvatica	European beech	Rotbuche
Fraxinus excelsior	European ash	Gemeine Esche
Juglans regia	Common walnut	Walnuss
Larix decidua	European larch	Europäische Lärche
Picea abies	Norway spruce	Gemeine Fichte
Pinus sylvestris	Scots pine	Waldkiefer
Prunus avium	Wild cherry	Vogelkirsche
Pseudotsuga menziesii	Douglas-fir	Douglasie
Quercus petraea	Sessile oak	Traubeneiche

Latin Name	English Name	German Name
Quercus robur	Pedunculate oak	Stieleiche
Quercus rubra	Red oak	Roteiche
Salix alba	White willow	Silberweide
Sorbus aucuparia	Rowan (European mountain ash)	Vogelbeere
Taxus baccata	European yew	Gemeine Eibe
Tilia cordata	Small-leaved lime	Winterlinde
Ulmus glabra	Wych elm	Bergulme

4. Excursion report

Day 1 - Forest service Ingoldstadt – Pfaffenhofen

Theme: Introduction to German/ Bavarian forestry; climate-adapted forest management

As an opening to the excursion, foresters from the AELF Ingolstadt–Pfaffenhofen outlined Bavaria's forest in facts and figures. Forest covers about 2.6 million ha (~35% of the state). Standing timber amounts to ~1.011 billion m^3 (solid), with an average 405 m^3/ha—the highest among Germany's federal states. Average stand age is ~88 years and the annual increment ~25.7 million m^3 (~10.4 m^3/ha). Each year, roughly 22.1 million m^3 are harvested and ~3.3 million m^3 are lost naturally (storms, dieback). Conifers still dominate (~62%), led by Norway spruce, followed by Scots pine, Silver fir, European larch, and Douglas fir. Broadleaves make up ~38%, with European beech, Oaks (*Q. robur*, *Q. petraea*), Maples (*A. pseudoplatanus*, *A. platanoides*), Birches (*B. pendula*, *B. pubescens*), European ash, and others (e.g., Hornbeam, Poplars).

Ownership is highly fragmented: ~56% belong to ~700,000 private owners averaging ~2 ha; over 70% own <2 ha, and ~1% hold >20 ha. The remainder is state (30%), municipal (12%), and federal (2%) forest. Policy aims at close-to-nature, integrated forestry that sustains ecosystem services and builds climate resilience. The transition from even-aged monocultures to highly structured mixed stands rests on three pillars: (1) promoting natural regeneration, especially of rarer native species; (2) cautiously testing southern provenances of native trees for drought tolerance; and (3) limited use of alternative, non-native species such as Douglas fir, Red oak, and Atlas/Lebanon cedar. To spread risk, managers target ≥4 tree species/ha, matched to site conditions. Early, continuous tending prevents vitality loss and leads toward vertical and horizontal structural diversity. Natural dynamics are encouraged via set-asides, microhabitat protection, and deadwood retention.

Two comparisons with the United States stood out: many U.S. forests often host 15–20 tree species/ha, well above the 1–2 species/ha common in much of Central Europe; and U.S. foresters frequently operate at far larger scales. Nationally, the U.S. has ~331 million ha of forest (36% of land), with ~59% private and ~30% federal ownership (National Association of State Foresters, 2019).

Day 2 – Bavarian State Forest enterprise BaySF Neureichenau

Theme: Sustainable forest management under climate change; water management

The Bavarian State Forest Service in Neureichenau manages the region's mixed mountain forests with a close-to-nature approach. Age-class cuts are avoided in favor of single tree harvesting. Regeneration relies primarily on natural processes, complemented by targeted enrichment of pure conifer or European Beech stands with native broadleaves and Silver fir through planting or seeding. Biodiversity is promoted by combining minimal-impact operations with set-aside areas and by retaining habitat trees and deadwood.

Management also balances public benefits and economic viability. Valuable timber is produced through selective harvesting and "biological automation," for example reducing tending by using natural branch self-pruning. Browsing pressure and thus regeneration costs are lowered by actively managing roe and red deer populations. Low- or negative-margin assortments are generally avoided.

Climate adaptation is a central priority. Vitality is favored over traditional timber quality, stands are structured to retain more water, and a stable within-stand microclimate is maintained. Species selection emphasizes drought tolerant native species and provenances over non-natives. This integrated forestry approach aims to deliver multiple ecosystem services—biodiversity, timber, water protection, and recreation on the same area.

Set-aside areas remain limited (430 ha of 18,000 ha), so the enterprise invests in micro-habitat restoration, especially in younger stands, by fostering deadwood, habitat trees, and rare habitats (see Fig. 2). A major climate-related challenge is bark beetle (*Ips typographus*). Warmer winters and springs now allow up to four generations per year. During our early May visit, staff were already scanning for signs of infestation (sawdust, resin flow, needle discoloration) to remove infested trees quickly (see Fig. 3). Detection and harvesting are efficient; the bottleneck is transport and storage, which is partly mitigated by operating a dedicated wet-storage facility.

To address shifting precipitation regimes and heavier downpours, water retention and erosion control measures include improved skid-trail design (avoiding diagonal alignment), retention basins (see Fig. 5), surface protection, and controlled crossfall drainage.

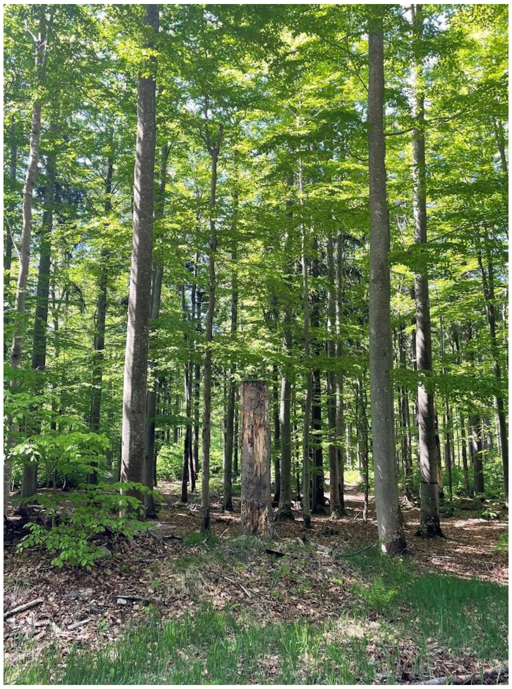

Figure 2: Active habitat creation in comparatively young stands © Sophie

Figure 3: On-set of bark beetle infestation in Spruce © Emely Benfer

Figure 4: Norway spruce and Rowan natural regeneration on a disturbance patch © Sophie Roberts

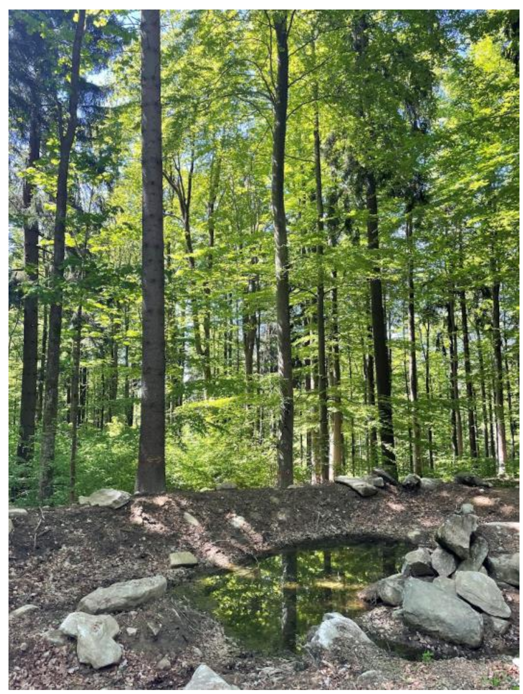

Figure 5: Water retention basin © Sophie Roberts

Day 3 - National Park Bayerischer Wald

Theme: Forest ecology, natural dynamics, non-intervention policy and its public perception, leisure management

The Bavarian Forest National Park, Germany's first national park founded in 1970, is situated on the German–Czech border. Together with the adjacent Šumava National Park (see Fig. 8), it forms a large transboundary forest landscape dominated by montane spruce–beech–fir forests, raised bogs, wind exposed ridges, and cold, humid plateaus. The parks core zone is a strict non-intervention area where active timber management is suspended and natural processes such as windthrow, insect outbreaks, and succession are explicitly accepted as the primary drivers of structure, habitat creation, and long-term biodiversity. The core zone is surrounded by buffer zones with limited management.

The Bavarian Forest National Park applies a clear principle in its core zones: "process protection" i.e. letting natural dynamics unfold without sanitation logging. Since the late 1980s, multiple waves of spruce bark beetle (*Ips typographus*) reshaped high-elevation spruce forests, creating large patches of standing and downed deadwood followed by natural regeneration (see Fig. 7). The resulting deadwood and gap mosaics have been intensively studied: across taxa, habitat heterogeneity and deadwood are associated with increases in species richness and turnover, especially for saproxylic insects, fungi, and cavity users, while also maintaining water quality in small catchments (Beudert et al., 2015; Müller et al., 2010)

Public reactions were and sometimes remain mixed. Visitors tend to show neutral to slightly positive attitudes toward non-intervention where expectations of "re-greening" and understanding of natural recovery are addressed, yet local controversies surge when visual change is rapid or overlaps with tourism and identity (Müller, 2011; Müller & Job, 2009). Over time, the "forest of tomorrow" becomes visible: regeneration under deadwood, with Norway Spruce, Rowan, European beech, and others establishing. The park thus serves as a reference landscape for disturbance driven dynamics, contrasting neighboring approaches such as rapid sanitation on e.g. the areas of the BaySF Neureichenau visited the previous day.

Figure 7: Standing deadwood from bark beetle outbreaks and natural spruce regeneration in the NP Bayerischer Wald © Klara Voggeneder

Figure 8: View towards the vast forest area of Sumava national park © Klara Voggeneder

Day 5 - Private forest enterprise Czernin-Kinsky Forstgut Rosenhof

Theme: Sylvicultural treatment of spruce forests and conversion to mixed forests

Unlike many private owners, the enterprise of Czernin-Kinsky relies exclusively on natural Norway spruce regeneration and low stem densities to build stable stands with a height-to-diameter ratio H/D < 80. The production goal is B-quality spruce (strength class 3a–b) with a max DBH ~40 cm, on 70-80-year rotations. Regeneration begins under shelter; once regeneration reaches 3-4 m top height, density is reduced to ~2,000 stems/ha. After final overstory removal, it is reduced again to ~1,000 stems/ha (vs. 2,000-2,500 in standard spruce silviculture), promoting diameter growth before the first thinning. The first thinning lowers density to ~600 stems/ha, and because the initial density is low, the stand already yields merchantable stem wood (<18 cm) rather than polewood. A second thinning around mid-rotation (~30 years) aims for a crown: stem ratio ~ 1:1 (~20 m crown, 20 m stem) (see Fig.9). The final thinning leaves ~250 trees/ha, reopening shelter conditions to restart natural regeneration.

Ecological payoffs include higher stability (lower H/D), better water availability, richer understory, and more active soil biota. Economically, the approach widens diameter distributions and brings earlier revenue from the first thinning, improving margins.

Today the forest is ~90% Norway spruce and ~10% European beech, Scots pine, and others. Despite relatively low bark beetle pressure due to climatic conditions, the 2100 target is 50% Norway spruce, 20% Silver fir, 10% European beech, 20% other species. The main challenge is seed limitation: with spruce dominating, desired species (e.g., Silver fir, Oaks) often require planting. Conversion proceeds by planting 500-600 trees/ha into partially opened mature spruce stands, preferably near old rootstocks to benefit from nutrient release as they decay.

Operationally, the enterprise runs in-house crews (five fellers) plus its own forwarder. It works with a modest interest rate ~1.5-2%/year (in contrast to U.S. TIMOs (Timber Investment Management Organizations) at ~7-8%/year).

Figure 9: Norway spruce stands with notably higher green crown portion © Sophie Roberts

Figure 10: Cedar growing on a species and provenance trial by the state of Upper Austria on the Czernin-Kinsky estate © Christopher Gunderson

Day 6.1 – Private forest enterprise Forst- und Gutsverwaltung Schönborn

Theme: Sylvicultural treatment of Oak and Douglas fir stands for high value timber

The management goal of the Schönborn enterprise is high-value timber from Sessile oak, Douglas fir, and Wild cherry i.e., long knot free stems with target DBH of ≥70 cm (Douglas fir), ~65 cm (Sessile oak), and ≥60 cm (Wild cherry). We saw a gradient of stand ages and treatments. Douglas fir and Wild cherry stands (see Fig.11), as well as planted Sessile oak, were systematically pruned to create a clear stem over roughly two-thirds of the diameter, matching guidance to combine thinning with pruning to ~5-6 m to produce knot free timber (Nicolescu et al., 2023). For Wild cherry, high-quality timber generally requires pruning, ideally before branches exceed ~3 cm to speed occlusion and limit decay risk, with a final green crown of ~40% of tree height (Pryor, 1988). In naturally regenerated oak beneath European beech shelter, dense cohorts were not pruned because self-pruning at high density forms clear stems. European hornbeam was used as a serving species to shade stems, suppress water sprouts and understory, and contribute rapidly decomposing litter, an approach supported by trials that deploy shade tolerant nurse species (including European beech and hornbeam) to improve oak form (Saha et al., 2017).

Economically, pruning affects revenue margins. We were told costs are ~10-12 € per tree, with a value uplift of ~50-70€/m^3 when knot free wood is achieved; studies likewise report substantial added value for well pruned logs (~80€/m^3 more in some Central European cases) (Nicolescu et al., 2023). On Sessile oak, the enterprise reports a significant delta in costs between planted and pruned (~6000-8000€/ha) versus naturally regenerated/self-pruned stands (~1600€/ha). Nevertheless, veneer and other A-class timber constitute only ~5-6% of harvest by volume.

Lastly, we saw a coppice with standards system with European hazel as coppice and Sessile oak as standards. It is a highly biodiverse stand; experimental restorations show that reintroducing coppice with standards can rapidly recover these taxa (Vild et al., 2013).

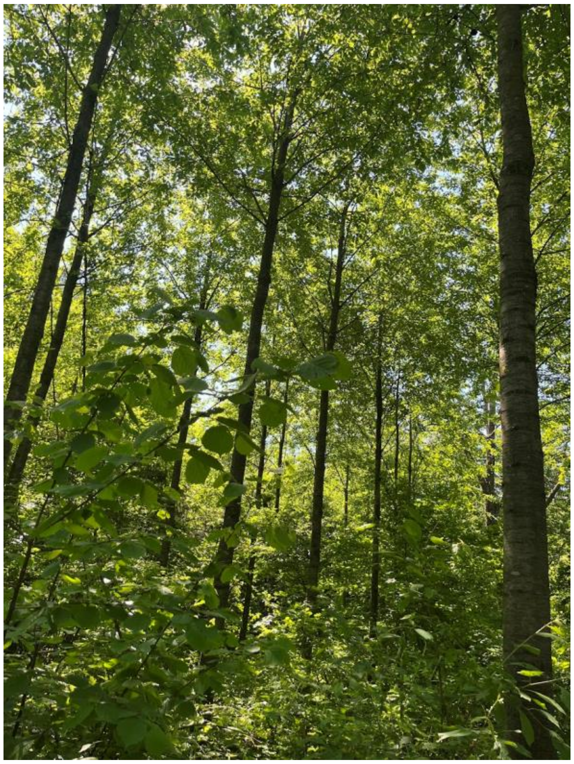

Figure 11: Vey high quality Wild cherry stand © Klara Voggeneder

Figure 12: High quality European beech stand © Klara Voggeneder

Day 6.2 – Private forest enterprise Forstverwaltung Ernsthof

Theme: Permanent/continuous-cover silviculture in mixed stands

At Ernsthof, management follows a permanent forest/ continuous-cover philosophy, with harvesting based on single-tree selection rather than age-class cuts and a production target for Oak of ~50 future crop trees/ha reaching ≥60 cm DBH within ~80 years.

From about age 30–40, regeneration is initiated with two shelterwood entries roughly 10-15 years apart, each reducing stem numbers by ~30%. The first, moderate opening favors European beech; the second, wider opening favors light demanders such as European larch and Sessile oak. Tending priorities favor Oak, then rare broadleaves (Sycamore maple, Wild cherry, Birch, European mountain ash), then European beech. Birch is used deliberately as a trainer/nurse: it controls microclimate, protects regeneration, and if thinned on time yields saleable assortments on short rotations.

On a steeper site, a former disturbance patch was left to natural regeneration, producing a diverse mix of species (European mountain ash, European beech, Sycamore maple, Birch, Douglas fir, European larch, Norway spruce, Silver fir and Scots pine) as pioneers established first and shade tolerant species filled in beneath (see Fig.13). Retainer ("Überhälter") trees such as Sessile oak, European larch and Scots pine are held for a second rotation on gentle terrain as seed and structure trees and for added value, but are avoided on steep slopes due to risky, costly extraction of large logs. At Ernsthof Douglas fir is found in natural regeneration, it can establish under canopy and is being tested as a drought tolerant alternative to failing Norway spruce, though debates continue about biodiversity and invasiveness trade-offs.

In the discussion, one aspect when judging mixture effects was emphasized: metrics matter. Pretzsch et al. (2018) found that positive mixture effects regarding stem volume can be misleading if declining wood density with accelerated growth is not considered. Generally, long term experiments in Europe show a widespread overyielding in mixtures through denser crown packing and higher growth efficiency, accelerated volume growth in recent decades, and a century scale decline in wood density, meaning that biomass/carbon trends may rise less than volume trends. Thus, for climate targets and risk evaluation, carbon based comparisons should be favored over volume alone (Pretzsch et al., 2014, 2018; Pretzsch & Schütze, 2021).

Figure 13: Disturbance patch with retainer trees and ample, species-rich natural regeneration © Christopher Gunderson

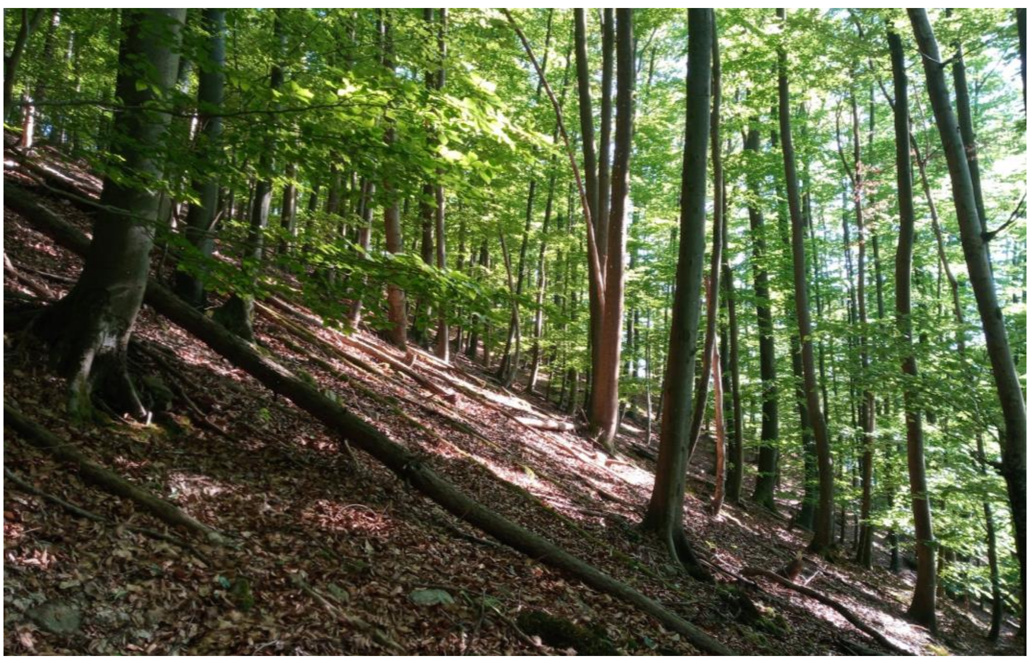

Figure 14: European beech dominated forest with visible diameter spread and lying deadwood at Ernsthof © Tamira Ravet

Day 7 - Austrian State Forest enterprise ÖBF Traun-Innviertel

Theme: Mountain forest management; steep slope forest operations; forest road construction

After a brief introduction to the Austrian State Forests (ÖBf), the day's main focus was harvesting in steep terrain. We observed a thinning in a 40-year-old Norway spruce–European beech mountain stand on an 80% slope (~39°), executed with a cable-assisted harvester and forwarder (see Fig. 15). This system handled ~150 m^3/day, more than double the output of a traditional cable yarder setup (~60 m^3/day). The assisted forwarder carried up to 10 t per load. For this stand, the target diameter is 50 cm on a ~120-year rotation. Because of the terrain, thinning could not begin until age ~40, rather than the preferred ~20–25 years (before the culmination of thickness increment), as suitable technology for safe, cost-efficient work on such slopes had not been available. The demonstration highlighted the advantages of tethered systems in maintaining traction and reducing soil impact and stand damage compared with older approaches, while meeting production goals in protection-forest settings.

After the harvesting demonstration, we examined additional stands, including an older, European beech dominated forest whose mixture with Sycamore maple, Silver fir, Norway spruce, and European larch more closely reflects the natural forest community of the region. Nevertheless, many forests here remain Norway spruce dominated, in part due to their historical role as saltworks forests. For centuries, timber was floated on the river Traun to Hallstatt and used as fuel for salt production; European beech proved too heavy for floating, so spruce was favored and both harvested and planted extensively. In 1596, a ~40 km brine pipeline constructed from ~13,000 spruce logs connected Hallstatt to Ebensee, making the dangerous river drives obsolete. At Ebensee, salt was extracted in brewhouses by heating brine in large "saltpans." By 1693, Ebensee was producing more salt than the towns of Hallstatt and Bad Ischl combined, further increasing the demand for timber and driving extensive clear cutting across the region (Reiter, 2007). This industrial legacy still shapes present day composition and management.

Figure 15: Cable assisted forwarder © Klara Voggeneder

Figure 16: Forest road construction @ Rohith Haritatsa

Day 8 – Private forest enterprise Mayr-Melnhof

Theme: Private forest management and hunting

The Mayr-Melnhof enterprise is among Austria's larger private forest owners, with annual turnover of about €3 million: roughly 40% from forestry (primarily timber sales), 30% from leasing and real estate (offices, quarries, restaurants, natural burial sites), and the remainder from diversified side businesses (e.g., a game meat butchery). Staffing comprises one forester, five hunters, and two workers with additional hunting duties; all harvesting and forwarding is done by contractors. Hunting is carried out by the family, staff, and invited guests (no per-head sales of shots).

Game in the forests is diverse: red deer, chamois, roe deer, mouflon; carnivores such as red fox, badger, pine and stone marten, otter; small game including marmot, beaver, hare; and feathered game (e.g., black grouse, capercaillie, raptors, owls). The estate operates two red deer and ~20 roe deer feeding stations. The forester's brief is to balance huntable populations with forest protection, limiting browsing and bark rubbing while sustaining regeneration. His management strategy combines (1) strict winter quiet, (2) targeted feeding, (3) stand mixtures with ≥3 tree species/ha including 1-2 broadleaves to open canopies and increase herbaceous plants and (4) hunting. He contrasts this with BaySF's approach, which he views as relying primarily on hunting without equivalent emphasis on stand structure or feeding to moderate damage. Large predators (notably wolf) were discussed briefly: their presence can make ungulates more cautious, shifting activity away from feeding sites and deeper into cover, with the side effect of intensified browsing.

Silviculturally, our visit focused on reforestation after storm damage from Kyrill (2007) and Emma (2008) (~80 ha), and on a site affected by a forest avalanche (2009) (see Fig. 17 and 18). While avalanches are often associated with alpine open terrain, ground/wet snow avalanches can initiate within forests where stocking density is low, litter layers (especially broadleaves) reduce snow–soil bonding, snow is wet, and slopes exceed ~50% (~27°). Management responses emphasize dense, multilayered cover, small openings, and timely regeneration to maintain protection functions while securing future timber production.

Figure 17: Frank Diehl showing an aerial picture of downed spruce after a windstorm in front of the affected patch (behind sanitation felled logs) @ Rohith Haritatsa

Figure 18: Frank Diehl showing pictures of a forest/ wet snow avalanche lane @ Christopher Gunderson

Day 9 – Bavarian State Forest enterprise BaySF St. Martin (Saalforste)

Theme: Hunting and silviculture in former salt-mining forests

The Bavarian State Forests' Saalforsten are unusual: they lie in Austria but belong to the Free State of Bavaria under the 1829 Saltworks Convention, which ended a long dispute between Salzburg and Bavaria over the Reichenhall saltworks and the timber from the Saalach Valley. In this treaty, the tax free ownership rights of the Crown of Bavaria to the forests for the Reichenhall saltworks were recognized "for all time.", while the state of Austria was permitted to mine salt at the Dürrnberg on Bavarian territory. Today, the Saalforsten comprise 18,600 ha with an annual harvest of roughly 40,000 m^3, administered from St. Martin, and remain a significant economic actor and one of Salzburg's largest forest owners („Die Bayerischen Saalforste", o. J.)

Management follows close-to-nature silviculture, yet centuries of Norway spruce oriented saltworks forestry still shape composition. While European beech would naturally account for about 25%, its current share is only ~9%. The strategy is to increase European beech and Silver fir, maintain European larch, and reduce Norway spruce. A key constraint is ungulate browsing, which in places removes about 10% of Silver fir and European beech regeneration annually. Although red deer and chamois numbers have been broadly stable since the 1990s, roe deer increased; higher culls have since reduced terminal bud browsing, bringing silver fir damage below 10% (2011–2021) and improving establishment prospects.

Silviculturally, we examined a 2016 windthrow left to natural regeneration toward a mixed mountain forest, aiming for a combined ~50% of Norway spruce, Silver fir, and European larch (see Fig. 19). Only European larch was planted at about 1,100 trees/ha on root stocks to access moisture and nutrients on shallow soils; the forester noted that half that planting density would likely have sufficed. Early tending of European larch and Silver fir is planned in 5–10 years to secure the intended mixture. A second site was a continuous cover stand managed by single-tree selection and shelterwood gaps. Here, shade tolerant species (e.g., Silver fir) are favored under small openings, whereas light demanders (e.g., European larch) struggle; as a rule of thumb, gaps < 1/3 of stand height favor shade tolerant regeneration. A local issue in humid, shaded microsites is Dreyfusia nordmannianae (migratory silver fir adelgid) on Silver fir.

Lastly, we visited a fenced stand with naturally regenerated European yew with seedlings (~20 cm height) staked and protected in an effort by a previous forester to restore rare native conifers within these forests (see Fig. 20).

Figure 19: Windthrow patch from 2016 with natural regeneration and retainer trees visible © Emely Benfer

Figure 20: European yew regeneration © Rohith Haritatsa

5. Conclusion

Over ten days we experienced a wide range of forests in Bavaria and Austria—differing in ownership, site conditions, and management objectives. Across this diversity, to me one theme stood out: climate change and with-it disturbance risk and the need for climate adapted forestry. How urgent the issue is rated, however, varies with context such as elevation, temperature and precipitation regimes, soils, exposure and with the prevailing management model at stand and landscape scales.

A common strategic response is risk spreading through diversification, both in tree species and in vertical and horizontal stand structure. Many owners increasingly rely on natural regeneration, either following disturbance or under shelterwood, as a cost - effective pathway toward mixed stands, using single tree selection and harvesting to favor desired species. Where seed sources are lacking, native and, to a limited extent, non-native species are planted for enrichment. For native species, several enterprises are testing southern provenances for increased drought tolerance. This is supported by evidence from Central Europe suggesting that species mixtures can maintain or increase stand productivity and growth efficiency across much of the rotation, supporting the diversification logic we observed (Pretzsch & Schütze, 2021).

Disturbances and post disturbance management were prevailing discussion points. Remote sensing data shows that, between 1986–2016, disturbance frequency increased across Europe with ~17% of the forest area having been disturbed at least once. Reviews anticipate further intensification of several disturbance agents under warming, notably drought insect and wind interactions, reinforcing the need to adapt proactively (Seidl et al., 2017). While disturbance frequency increased severity decreased. These non-stand-replacing (NSR) events lead to finer grained forest reorganization rather than complete stand loss in many places (Senf & Seidl, 2020). Generally, structure after disturbance depends strongly on the agent (wind, insects, drought) and intensity; low to moderate severity often yields heterogeneous, partially retained canopies (Coops et al., 2020) that could be steered toward the very outcomes managers seek if natural regeneration is protected and tending is timely, namely structurally diverse, species rich temperate forests. Recent work also emphasizes that post disturbance "reorganization" proceeds along multiple dimensions (composition, structure, and functioning), underscoring the potential value of disturbances in moving towards resilient "forests of the future" (Seidl & Turner, 2022).

To conclude, this 10-day excursion was highly enriching - practically, scientifically, and interculturally. Lively discussions about similarities and differences in silvicultural practices between Austria/Germany and the United States often continued well beyond the formal program.

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