Supplement to article: SACHER et al.: An interdisciplinary story-and-simulation approach for assessing forest type changes and shifts in ecosystem service potential.
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Supplement

Supplementary Methods: Scenario texts

Status Quo Scenario (SQ)

In this scenario, the development of the forests of Bavaria under constant influencing factors is described.

Change of forest share in the total area of Bavaria:
The experts are largely in agreement that the proportion of forest area in the total area of Bavaria will hardly change. Some slight increases are still forecast, especially in the regions particularly affected by population decline, as a result of the growth of abandoned agricultural marginal land. Only a few foresee a (slight) decline in the share of forest; The main reasons given are the increasing demand for renewable raw materials (for example energy crops) and the demand for land for renewable energies (photovoltaic systems) as well as for infrastructure projects such as roads or industrial areas close to settlements.

Change in the ratio of deciduous to coniferous trees:
There is a high level of agreement that the ratio of deciduous to coniferous wood will shift due to forestry remediation and biological disturbances in the coniferous woodlands in favor of the deciduous part; These estimates range up to 50% of hardwood (though not until 2075). At the same time, however, attention is drawn to differences between developments in state and private forests, since in the latter case the proportion of softwood will probably remain high (demand for rapidly growing timber). The role of Douglas fir as a non-local spruce substitute (better adaptation to climatic changes and higher resistance to pest infestation) is controversial or unpredictable among experts; first successes with this tree species, however, argue for a further increase in the share. In addition, other guest tree species such as cedar or tree hazel will be increasingly used in forest planning.

Change in the proportion of semi-natural areas on the forest area:
Most experts see a slight to moderate increase in the proportion of semi-natural areas as probable (including a higher proportion of deciduous trees). However, due to the simultaneous displacement effects of foreign tree species as a consequence of constant climate change, this development could be partially dampened.

Change in the average proportion of deadwood in the forests of Bavaria:
The majority of experts think that an increase is likely. The reasons for this are particularly the developments in protected areas and the stipulations of (contract) nature conservation. In doing so, both the external influences of nature conservation organizations and their own nature conservation concepts, e.g. the Bavarian State Forests stressed. Also, there will be a greater variety of deadwood forms (e.g., young, old, standing next to each other) within a forest area. Thus, it is not possible to speak of a general increase in the amount of deadwood, but more of an increase in structural diversity.

Change in the importance of timber production:
There are two opposing tendencies here. On the one hand, on some areas, wood production will increase or increase in importance due to increased demand; on the other hand, more land will be taken out of use in favor of nature conservation. Both developments seem to run at the same time, suggesting that the different ideas of the role of forests are moving farther apart. The fact that the vast majority of Bavaria's forests consists of commercial forests, however, would mean that use intensification would have far greater dimensions.
Only a few experts expect no change.

Change in the recreational value of the forests of Bavaria:
Both, a steady and a further increase in the recreational value is considered likely by the experts. In the event of a further increase, particularly increased leisure time demands of the population as well as a rise in tourism and outdoor activities are cited as the main reasons. The wider range of different forest conditions from the classic forest to "wilderness areas" in protected areas will also play a role here. However, there will be a differentiation in the perception of the recreational value due to the recreational pressure in the urbanized regions (peri-urban forests have a high recreational value per se, regardless of their condition). Also, a segmentation of the forests according to different areas of use, depending on the recreational value, would be conceivable.

Change in the importance of nature conservation measures:
Nature conservation measures and nature conservation will in some cases gain considerable importance. But here, too, the opposite of quantity vs. quality is seen, as some conservation measures may be expensive and yet inefficient, or they may not actually enhance naturalness (for example, too much human intervention before natural development can occur). Accordingly, there will also be a further specialization in nature conservation.

Change in the proportion of threatened animal and plant species:
The proportion of endangered plant and animal species will rise moderately to significantly under constant influencing factors. Few experts see any contrary development as likely. In this context, forests represent the "more stable" living space in comparison, for example, to the agricultural landscape. In particular, persistent climate change poses a high threat to a variety of species, but other anthropogenic influences will also be added. In the best case, there will be a stagnation of currently threatened species and habitats.

Change in the geographical distribution of forest areas:
In this most experts do not expect any significant changes. At best, a greater fragmentation of existing forest areas, especially for infrastructure projects, could occur. There will also be a slight shift of the forest focus towards northern Bavaria due to the increased population pressure in the south.

Change of ownership:
There will hardly be any changes in ownership. Possibly, a slight increase in the private forest share is to be expected, as forest ownership could become more attractive to persons or interest groups that previously had little relevance to forests.

Alternative scenario I (ASC I) "Intensification of Use"

In this scenario, the development deviating from the status quo scenario is described under such drivers that will change according to the experts' assessment.

For the **forest area**, a slight increase is expected as an alternative to the status quo scenario. This happens especially on abandoned marginal land of agriculture or in previously forest poorer areas.

The **ratio of deciduous to coniferous** trees will lead to a significant increase of the hardwood share. Estimates for the increase range up to a balanced ratio of 50:50. However, the use of non-native tree species that are adapted to the conditions of climate change will also be discussed. The Douglas fir, but also other guest tree species, will displace the spruce and could slow down the increase of the deciduous tree share in successful use.

The development of the **proportion of semi-natural areas in the total forest area** cannot be clearly shown in this scenario. An increase due to social demands or the introduction of exemplary certification systems (Naturland, FSC) as well as compensatory measures in the forest are to be expected. In particular, non-forestry land will become an integral part of forest management, the previous segregation in site-illegal, coniferous wood-dominated "forest plantations" and few remnants of semi-natural forests will increasingly blur.

For the **average proportion of deadwood**, the experts see stagnation or even a slight decrease due to the increasing pressure of use and increased use of timber. In this case, this coincides with the following developments in the field of timber use.

The **use of timber** will lead to an increase in importance or an increase in the previous use of timber. The reasons for this are above all the increased demand for timber and the transition of energy production in Germany. The use of plantations is not excluded. The intensification of the use of timber will therefore not affect the entire forest, but especially partial areas.

In contrast to the status quo, the **recreational value of the forests** in Bavaria will lead to an even clearer spatial differentiation. Due to the recreational pressure in the vicinity of urban areas, especially forests that are of interest for recreation will be increasingly in demand. In contrast, many forest areas - with the exception of protected areas - will be farmed more intensively and thereby at least partially lose recreational value.

In addition, the **influence of nature conservation measures** will tend to decrease in comparison to the status quo in order to compensate for the increasing pressure of use. Species protection may be due to other priorities, e.g. for climate protection, to have less significance in the future. As a result, the need for an extension of protective measures due to societal pressure would increase again according to the development of endangered species.

Endangered species as well as **habitats** will in this scenario become more in the future due to the intensification of use and due to changed priorities in forestry planning. Also, a displacement of indigenous by invasive species is considered probable.

There will be slight changes in the previous **geographical distribution of forest areas**. In urbanized areas, there will be displacement effects. In addition, due to increased population pressure in the south, the focus of the forest will shift towards northern Bavaria. A change in the altitudinal extent of tree

species is also likely in a further intensifying climate change. Nature conservation measures could lead to fusion or creation of corridors for specific species where possible and appropriate.

As within the status quo, there will hardly be any change in the existing **ownership structure** until 2075. At most, a trend towards privatization, presumed by some experts, could occur here. The option to be a forest owner will also become more attractive. For example, social changes can lead to small-scale parcels being bought (as an investment / additional pension).

Despite the comments on the increase of mixed proportions with climate-tolerant tree species (fir, beech, other hardwood), the **hunting conditions** and thus the quantity of **game** will hardly change.

Alternative scenario II (ASC II) "Resilient close-to-nature forests"

This scenario reflects the development of Bavaria's forests under the ideal development designed by several experts. In contrast to status quo and alternative scenario I, it therefore contains other aspects, but there is broad consensus on their future.

Influence of climate change on forest development:
Climate change has far less impact on forest development and tree species composition in Bavaria. This is associated with a stronger resilience of the native, but also the newly established tree species to climatic extremes and the associated consequences.

Sustainability in forestry:
The aspect of sustainability will increasingly influence forestry decisions and measures in the future. Care is taken to harmonize the sub-aspects of economy, ecology and social affairs, while none of these areas can be over-substituted by another. Nevertheless, in the field of economics, particular emphasis is placed on forestry, which must survive in international competition.

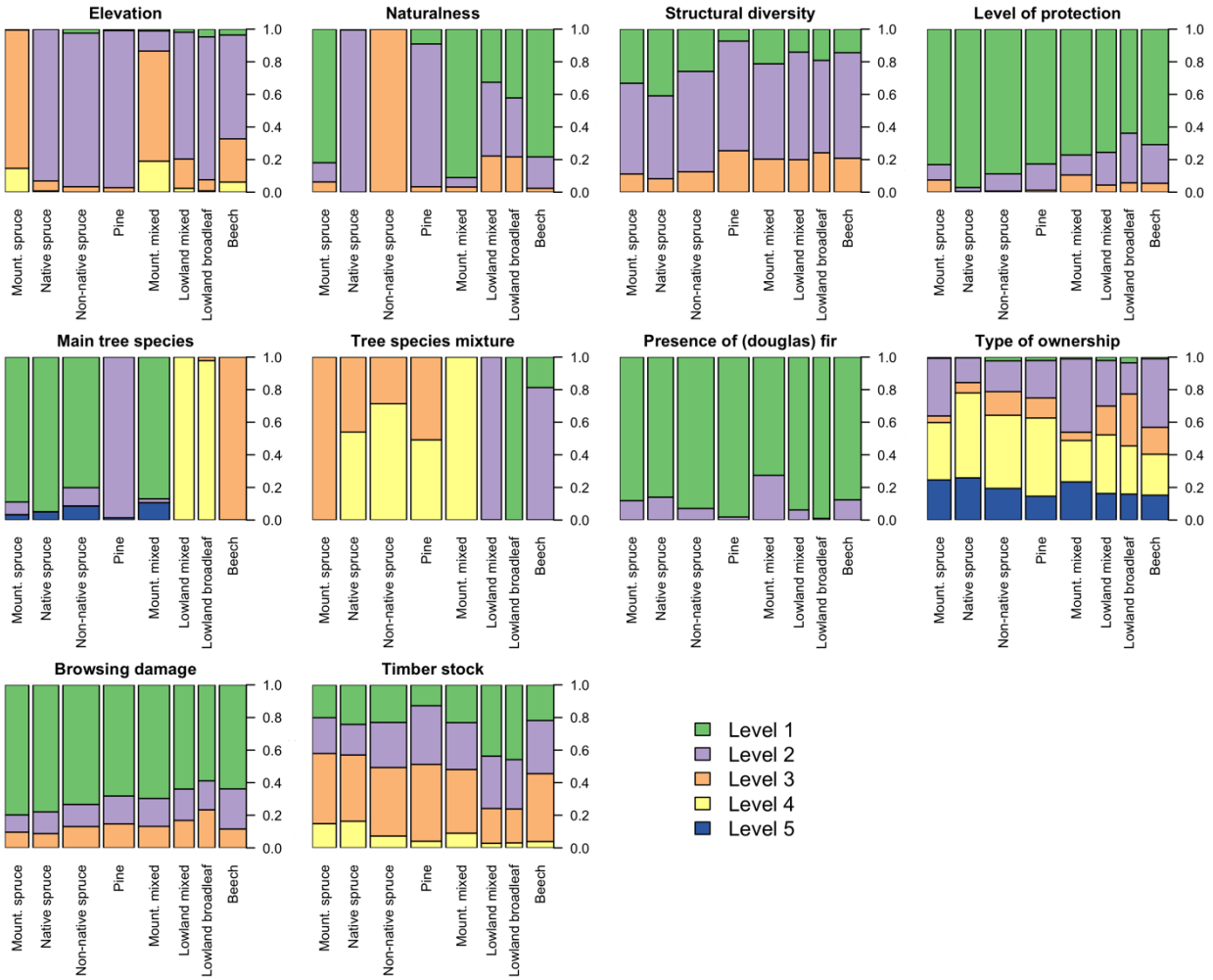
Future role of nature conservation:
According to this scenario, forest conservation will be caught between integration and segregation. This means that, on the one hand, extensive nature conservation will be pursued with simultaneous, nature-friendly use, but on the other hand, forests will be completely taken out of use wherever this makes sense and the conflict potential is low. A proportion of forests on which process protection can run, of up to ten percent, is regarded as a guideline.

Reduction of wild stocks:
In future, wild stocks will be more closely controlled and reduced to an ecologically compatible level through aimed hunting.

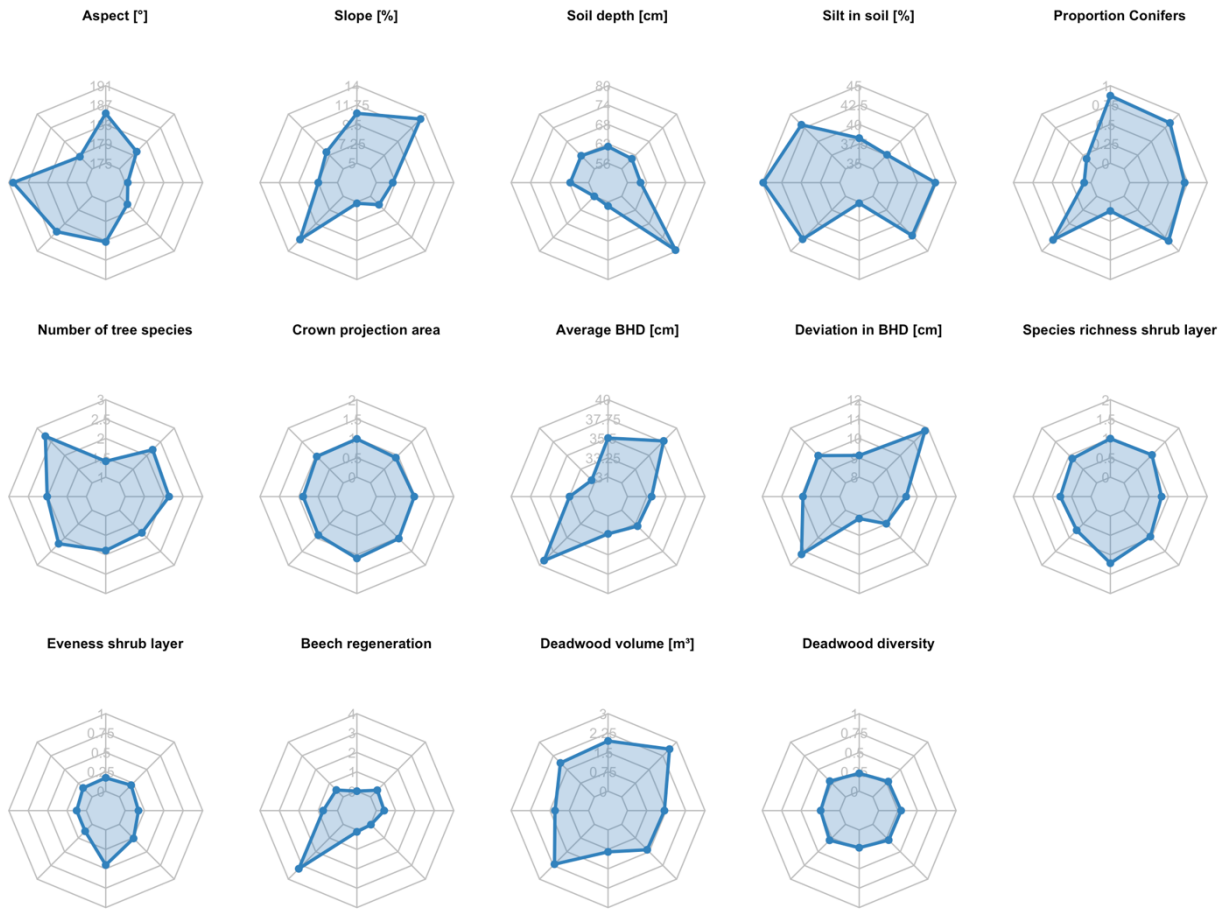
Recognition for the ecosystem services provided by forests:
In the future, the ecosystems services currently considered as self-evident, which are made available to the residents of Bavaria through forests, will be more strongly rewarded. Accordingly, certain payments to forest owners would be conceivable, depending on the area and ecological quality of certain forest areas.

Strengthening of ownership rights:
In this scenario, decisions and requirements of forest owners are less questioned by the legislator. Interventions in the ownership rights would thus be permitted only on the basis of public interest concerns. For this reason, the needs of the population in particular have to be taken into account regionally.

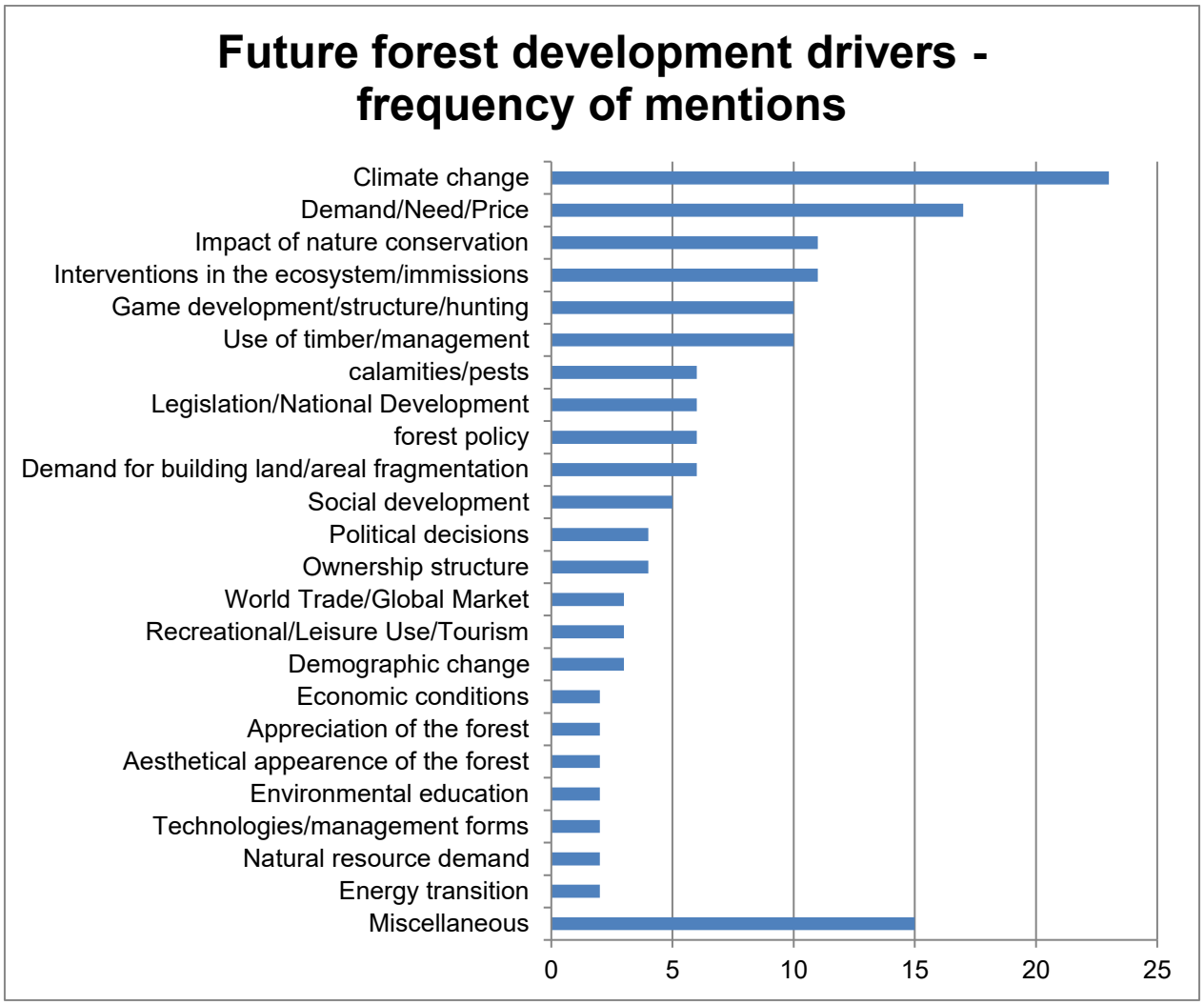
Increase in the recreational function:
The forests in Bavaria will become more important as an important space for recreation and regeneration, especially in the vicinity of settlements. Tourists, for whom Bavaria's forests are already a major attraction, will be in demand for a nature-friendly accessibility of the forests, so that peripheral and economically weaker regions will also benefit from their forests.



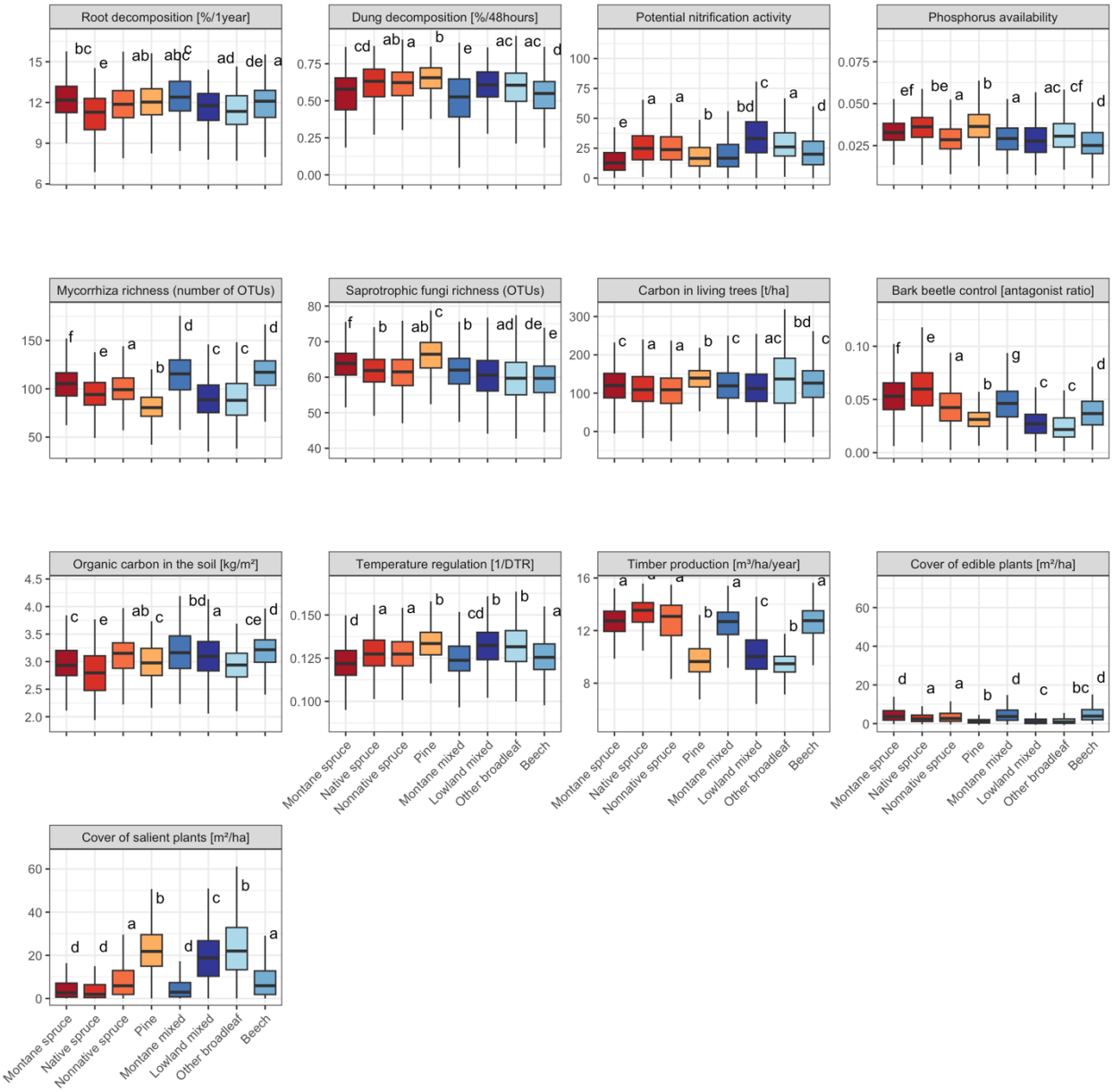
Supplementary Fig. 1: Distribution of categories used to define forest types in the cluster analysis. Values are number of inventory points given as proportions within each forest types. See Supplementary Table 1 for a description of the category levels.



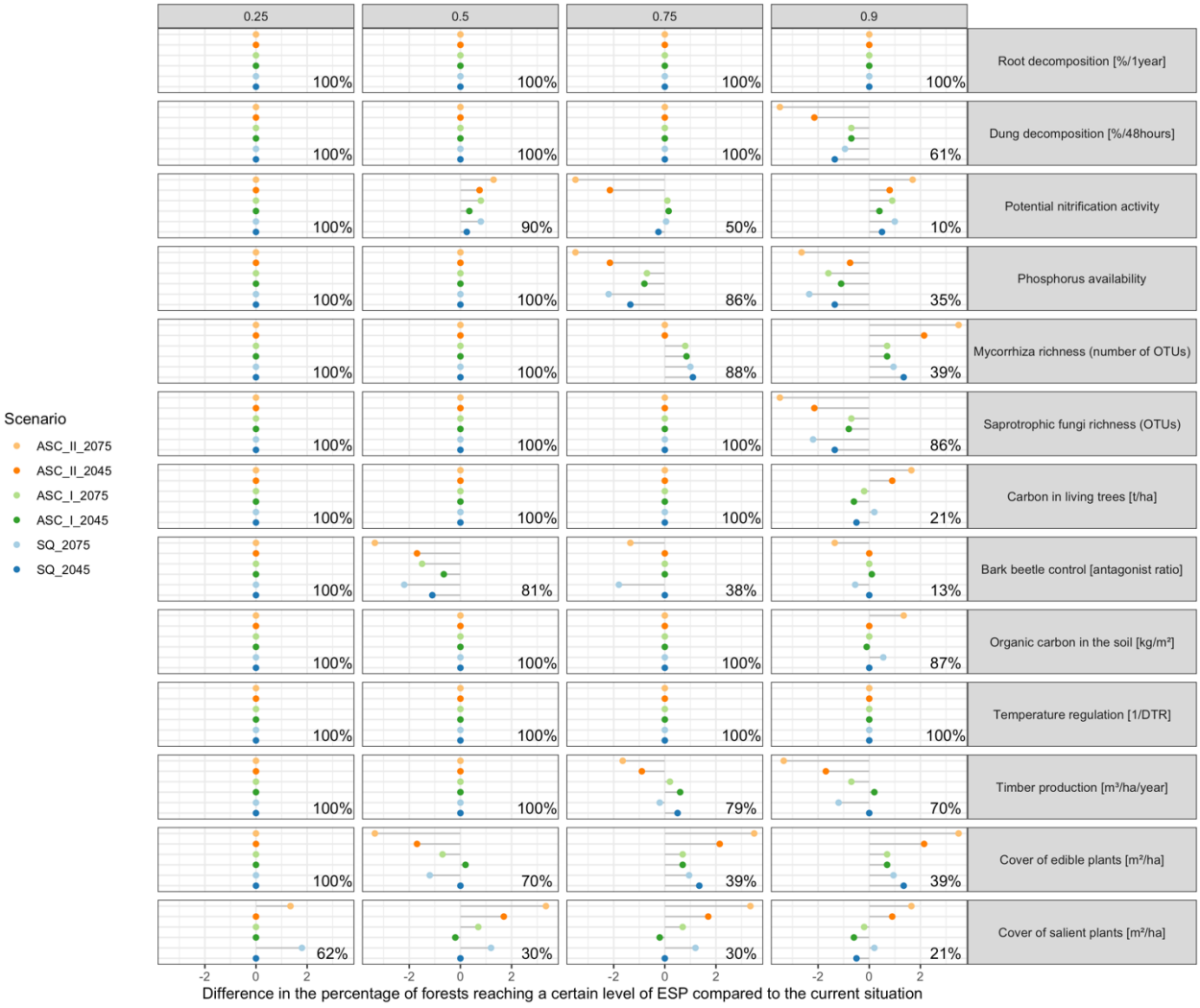
Supplementary Fig. 2: Average values of forest characteristics used as predictor variables within the predictive ES models across forest types in Bavaria. Each dot along the edge of the graphic area represents one forest type (starting on top in counterclockwise order): Montane spruce, montane mixed, non-native spruce, native spruce, pine, beech, other broadleaf and lowland mixed forests.



Supplementary Fig. 3: Main drivers of forest development in Bavaria (Germany) identified by an expert panel through an online questionnaire. Experts were asked to "name the drivers that (…) have a significant influence on the current and future development of forests in Bavaria". The experts could openly formulate up to ten aspects which were categorized afterwards. Drivers are sorted by the number of mentions across the expert panel.



Supplementary Fig. 4: Results from Tukey HSD tests following linear models between forest types for the predicted ecosystem services potentials. Different letters indicate significant difference in the average potential with $p<0.05$. Colors indicate different categories of forest types with warm colors indicating coniferous and cold colors indicating broadleaf or mixed forests.



Supplementary Fig. 5: Differences between scenarios in the percentage of the forest area (forest share) in Bavaria which reaches a certain relative level of ESP. Relative levels of ESP (columns) are relative to the maximum observed level across forest types within each ES. The forest share in the current situation (2012 NFI) is equivalent to the null point on the x-axis and given as percentage in the lower right corner of each box (for example, according to the 2012 NFI, 62% of the forest area has a cover of salient plants above an ESP level of 0.25 or higher, but only 21% of the forest area reaches a relative level above 0.9). The x-axis shows the change in forest share compared to the current situation for each scenario (color-coded and arranged along the y-axes). Negative values indicate a decrease in the percentage of forest share compared to the current situation. Colors indicate the different scenarios and timespans. SQ (blue): Status quo scenario with no change in drivers. ASCI (green): Alternative scenario I 'Intensification of use'. ASCII (orange): Alternative scenario II 'resilient and close-to-nature forests'.

Supplementary Tab. 1: Levels of categories used for the definition of forest types. Deadwood amount and age class were identified as important by the experts but not used for the clustering as those are expected to change strongly within the different scenarios.

Variable	Level 1	Level 2	Level 3	Level 4	Level 5
Elevation	colline	submontane	montane	subalpine	
Main tree species	Spruce	Pine	Beech	Other deciduous tree species	other coniferous tree species
Tree species mixture	Only deciduous tree species	mainly deciduous with conifers	Only coniferous tree species	mainly coniferous with deciduous	
Naturalness	close to nature	medium naturalness	culturally dominated		
Structural diversity	single layer	2-5 layers	multi-layered		
Timber stock (wood volume)	< 200 m^3/ha	200-400 m^3/ha	401-800 m^3/ha	> 800 m^3/ha	
Level of hunting	no young trees with bark damaged	< 50% of young trees damaged	> 50% of young trees damaged		
Proportion of fir / douglas fir	< 10% of trees	> 10% of trees			
Type of ownership	Federal forest	State forest	(public) corporation	small private forest (up to 20 ha)	large private forest
Level of protection	not protected	only restricted use allowed (e.g., EU-FFH reserve)	National park or biosphere reserve core zone (no use)		
Age class	1-60 years	61-80 years	81-120 years	older than 120 years or uneven-aged	
Amount of coarse deadwood	no deadwood	< 10 m^3/ha	10-20 m^3/ha	more than 20 m^3/ha	

Supplementary Tab. 2: We collected data on 13 indicators of ecosystem services, which cover the three main categories of ecosystem functions and services established by IPBES (IPBES 2019). The set of ecosystem service indicators is based on the data and methods used in SIMONS et al. (2021). Here, we provide a short description of their suitability as indicators and main references.

ES indicator	Unit of measurement	Motivation	Reference
IPBES category 'climate regulation'			
carbon storage in trees	Weight of carbon stored in living trees in tons per ha	Trees are important carbon sinks as they store carbon in their tissues via photosynthesis.	Yude *et al.* (2011)
soil carbon stocks	Weight of organic carbon in kg per m^2	Forest soils are important carbon pools.	Yude *et al.* (2011)
local temperature regulation	Inverse of the daily temperature range	Forests buffer extreme temperatures due to their dense canopy cover.	Frey *et al.* (2016)
IPBES category 'formation, protection and decontamination of soils and sediments'			
root decomposition	Biomass loss (%) per year	Fine root decomposition plays an important role in element cycling in forest ecosystems.	Hobbie (1992)
dung decomposition	Biomass loss (%) in 48 hours	Dung beetle communities contribute to the rapid decomposition of fecal deposits from both wild mammals and domestic livestock, representing a key ecosystem service.	Nichols *et al.* (2008)
potential nitrification activity	ng NO2/ g dry weight/ h	Nitrogen (N) can be a limiting element for plant growing and therefore limit the functioning of the ecosystem.	Vitousek & Howarth (1991); LeBauer & Treseder (2008)
phosphorus availability	mg extractable phosphorus per kg soil	Phosphorus (P) becomes increasingly important as a limiting element for plant growth and therefore might limit the functioning of the ecosystem.	Holland *et al.* (2005); Vitousek *et al.* (2010); Lang *et al.* (2017)

Supplementary Tab. 2 ***cont.***

ES indicator	Unit of measurement	Motivation	Reference
mycorrhiza richness	Number of OTUs	Saprotrophic and mycorrhiza fungi contribute to nutrient turnover by decomposing the organic material produced by plants. Higher species richness of saprotrophic communities has been associated with higher functional diversity and therefore healthier forests.	Courty *et al.* (2010); Clemmensen *et al.* (2013)
saprotrophic fungal richness	Number of OTUs		
IPBES category 'regulation of detrimental organisms and biological processes'			
bark beetle control	Ration between bark beetles and antagonists	Natural bark beetle control is an important forest ecosystem service that can have an effect on other services like production of quality timber and aesthetic value.	Jactel *et al.* (2009); Bengtsson (2015)
IPBES category 'food and feed'			
cover of edible plants	Cover of plant in m^2 per ha	A common use of forests is the collection of fruits, nuts, berries and other plant parts for cooking.	Gamfeldt *et al.* (2013)
IPBES category 'materials, companionship and labor''			
forest productivity	Timber production in m^3 per ha and year	Timber is one of the main products extracted from forests. Since harvesting records are not accurate at the plot level, we used the increment of the stand in wood volume per hectare and year as a proxy for forest productivity.	Schall & Ammer (2018)
IPBES category 'learning and inspiration'			
cover of (salient) plants	Cover of plant in m^2 per ha	Plants blooming in early spring in forests are highly appreciated for their aesthetic value.	Bhattacharya *et al.* (2005)

Supplementary Tab. 3: Average and uncertainty of transition probabilities between forest types under different scenarios and time horizons based on a panel of 11 experts. Initial forest types are given in rows, target forest types in columns. SQ: Status-quo scenario. ASC I: Alternative scenario I (Intensification of use). ASC II: Alternative scenario II (Resilient close-to-nature forests). N: number of experts who provided a value. AM: arithmetic mean. SE: standard error.

Target types / Initial forest types	I Mountain Spruce Forests			II Mountain mixed forests			III Non-native Spruce (mixed) Forests			IV Native Spruce (mixed) Forests			V Pine (mixed) Forests			VI Beech (mixed) Forests			VII Other lowland deciduous forests			VIII Other lowland mixed forests			IX Other land use		
SQ 2045																											
	N	**AM**	**SE**	**N**	**AM**	**SE**	**N**	**AM**	**SE**	**N**	**AM**	**SE**	**N**	**AM**	**SE**	**N**	**AM**	**SE**	**N**	**AM**	**SE**	**N**	**AM**	**SE**	**N**	**AM**	**SE**
(I)				11	5.18	0.86	11	1.09	0.51	11	1.18	0.79	11	0.09	0.09	11	2.00	0.78	11	0.00	0.00	11	0.00	0.00	11	0.82	0.44
(II)	11	1.09	0.71				11	0.73	0.43	11	0.55	0.24	11	0.36	0.23	11	4.09	0.87	11	0.09	0.09	11	0.00	0.00	11	0.73	0.43
(III)	11	0.18	0.17	11	1.55	0.58				11	0.91	0.70	11	1.82	0.61	11	5.55	0.84	11	4.27	0.88	11	3.18	1.01	11	1.00	0.46
(IV)	11	0.64	0.43	11	1.27	0.63	11	1.09	0.71				11	1.27	0.62	11	4.55	0.88	11	3.27	1.08	11	2.36	1.02	11	0.73	0.43
(V)	11	0.09	0.09	11	0.55	0.43	11	0.09	0.09	11	0.36	0.19				11	3.73	1.00	11	5.27	0.82	11	4.91	0.92	11	1.09	0.51
(VI)	11	0.00	0.00	11	0.55	0.30	11	0.09	0.09	11	0.36	0.23	11	1.00	0.60				11	3.36	0.78	11	2.45	0.81	11	0.73	0.43
(VII)	11	0.00	0.00	11	0.00	0.00	11	0.18	0.12	11	0.45	0.24	11	0.73	0.43	11	1.91	0.73				11	2.27	0.77	11	0.73	0.43
(VIII)	11	0.00	0.00	11	0.00	0.00	11	0.18	0.12	11	0.27	0.19	11	0.91	0.60	11	2.09	0.79	11	1.73	0.74				11	0.73	0.43
(IX)	11	0.55	0.20	11	0.55	0.20	11	0.18	0.12	11	0.36	0.15	11	0.36	0.15	11	0.55	0.24	11	0.55	0.24	11	0.55	0.24			
SQ 2075																											
	N	**AM**	**SE**	**N**	**AM**	**SE**	**N**	**AM**	**SE**	**N**	**AM**	**SE**	**N**	**AM**	**SE**	**N**	**AM**	**SE**	**N**	**AM**	**SE**	**N**	**AM**	**SE**	**N**	**AM**	**SE**
(I)				10	7.10	1.05	10	1.10	0.94	10	0.50	0.38	10	0.10	0.09	10	1.80	0.76	10	0.10	0.09	10	0.10	0.09	10	0.40	0.21
(II)	10	0.50	0.38				10	0.10	0.09	10	0.60	0.32	10	0.50	0.32	10	5.60	1.04	10	0.20	0.19	10	0.10	0.09	10	0.30	0.14
(III)	10	0.00	0.00	10	1.40	0.62				10	0.20	0.19	10	1.70	0.74	10	6.10	0.91	10	5.60	1.06	10	2.50	0.99	10	0.60	0.29
(IV)	10	0.70	0.57	10	2.20	0.78	10	0.70	0.49				10	1.00	0.49	10	6.20	0.75	10	4.40	1.31	10	3.00	1.30	10	0.30	0.14
(V)	10	0.00	0.00	10	0.30	0.28	10	0.10	0.09	10	0.60	0.32				10	4.10	1.22	10	5.10	1.01	10	5.80	1.09	10	0.70	0.38
(VI)	10	0.00	0.00	10	0.50	0.38	10	0.10	0.09	10	0.40	0.29	10	0.20	0.13				10	3.10	0.85	10	1.90	0.75	10	0.30	0.14
(VII)	10	0.00	0.00	10	0.00	0.00	10	0.10	0.09	10	0.50	0.32	10	0.10	0.09	10	1.30	0.68				10	1.50	0.60	10	0.30	0.14
(VIII)	10	0.00	0.00	10	0.00	0.00	10	0.10	0.09	10	0.30	0.28	10	0.10	0.09	10	1.30	0.68	10	1.10	0.52				10	0.40	0.15
(IX)	10	0.50	0.21	10	0.50	0.21	10	0.10	0.09	10	0.30	0.14	10	0.30	0.14	10	0.50	0.29	10	0.50	0.29	10	0.50	0.29			
ASC I 2045																											
	N	**AM**	**SE**	**N**	**AM**	**SE**	**N**	**AM**	**SE**	**N**	**AM**	**SE**	**N**	**AM**	**SE**	**N**	**AM**	**SE**	**N**	**AM**	**SE**	**N**	**AM**	**SE**	**N**	**AM**	**SE**
(I)				7	3.14	1.06	7	1.14	0.71	7	1.14	0.71	7	0.00	0.00	7	0.43	0.40	7	0.00	0.00	7	0.00	0.00	7	0.43	0.28
(II)	7	0.43	0.40				7	1.57	0.72	7	3.29	0.83	7	0.00	0.00	7	0.43	0.40	7	0.00	0.00	7	0.00	0.00	7	0.29	0.17
(III)	7	0.00	0.00	7	0.43	0.40				7	0.43	0.40	7	0.14	0.13	7	2.43	0.94	7	1.57	0.88	7	1.57	1.03	7	0.29	0.17
(IV)	7	0.86	0.79	7	1.00	0.78	7	0.57	0.53				7	0.14	0.13	7	0.57	0.40	7	0.86	0.65	7	1.00	0.78	7	0.29	0.17
(V)	7	0.00	0.00	7	0.29	0.26	7	0.29	0.26	7	0.86	0.65				7	3.00	1.25	7	2.43	1.28	7	0.43	0.28	7	0.29	0.17
(VI)	7	0.00	0.00	7	0.43	0.40	7	2.14	1.11	7	1.57	1.03	7	0.29	0.17				7	1.57	0.67	7	1.14	0.65	7	0.29	0.17
(VII)	7	0.00	0.00	7	0.00	0.00	7	1.71	0.83	7	1.00	0.67	7	0.29	0.17	7	1.57	0.83				7	1.00	0.53	7	0.29	0.17
(VIII)	7	0.00	0.00	7	0.00	0.00	7	1.71	0.83	7	1.00	0.67	7	0.29	0.17	7	1.57	0.83	7	0.43	0.28				7	0.29	0.17
(IX)	7	0.29	0.17	7	0.29	0.17	7	0.29	0.17	7	0.29	0.17	7	0.29	0.17	7	0.29	0.17	7	0.29	0.17	7	0.29	0.17			
ASC I 2075																											

	N	AM	SE	N	AM	SE	N	AM	SE	N	AM	SE	N	AM	SE	N	AM	SE	N	AM	SE	N	AM	SE	N	AM	SE
(I)				6	3.67	1.39	7	0.71	0.66	6	1.50	0.87	6	0.00	0.00	6	0.67	0.61	6	0.00	0.00	6	0.00	0.00	6	0.50	0.31
(II)	6	0.67	0.61				6	2.50	1.05	6	3.50	1.05	6	0.00	0.00	6	0.67	0.61	6	0.00	0.00	6	0.00	0.00	6	0.33	0.19
(III)	6	0.00	0.00	6	0.67	0.61				6	0.67	0.61	6	0.83	0.60	6	1.83	0.86	6	0.67	0.45	6	0.33	0.19	6	0.33	0.19
(IV)	6	1.17	1.07	6	1.33	1.05	6	0.83	0.76				6	0.17	0.15	6	0.83	0.60	6	0.33	0.30	6	0.33	0.30	6	0.33	0.19
(V)	6	0.00	0.00	6	0.50	0.46	6	1.50	0.94	6	1.17	0.89				6	2.17	0.89	6	1.33	0.65	6	0.67	0.45	6	0.33	0.19
(VI)	6	0.00	0.00	6	0.67	0.61	6	3.00	1.41	6	2.33	1.47	6	0.50	0.31				6	1.17	0.55	6	0.67	0.45	6	0.33	0.19
(VII)	6	0.00	0.00	6	0.00	0.00	6	3.00	1.41	6	2.17	1.50	6	0.50	0.31	6	1.17	0.89				6	0.67	0.45	6	0.33	0.19
(VIII)	6	0.00	0.00	6	0.00	0.00	6	3.00	1.41	6	2.17	1.50	6	0.50	0.31	6	1.17	0.89	6	0.67	0.45				6	0.33	0.19
(IX)	6	0.33	0.19	6	0.33	0.19	6	0.17	0.15	6	0.33	0.19	6	0.33	0.19	6	0.33	0.19	6	0.33	0.19	6	0.33	0.19			

ASC II 2045

	N	AM	SE	N	AM	SE	N	AM	SE	N	AM	SE	N	AM	SE	N	AM	SE	N	AM	SE	N	AM	SE	N	AM	SE
(I)				6	4.83	1.74	6	0.00	0.00	6	0.83	0.60	6	0.33	0.30	6	1.17	0.68	6	0.00	0.00	6	0.00	0.00	6	0.33	0.19
(II)	6	0.17	0.15				6	0.00	0.00	6	0.50	0.31	6	0.17	0.15	6	2.33	0.84	6	0.00	0.00	6	0.00	0.00	6	0.33	0.19
(III)	6	0.00	0.00	6	3.17	1.14				6	0.00	0.00	6	0.33	0.19	6	6.67	0.81	6	5.50	1.07	6	4.00	1.35	6	0.33	0.19
(IV)	6	0.17	0.15	6	2.83	1.16	6	0.00	0.00				6	0.67	0.45	6	6.00	0.91	6	3.50	1.66	6	1.83	1.21	6	0.33	0.19
(V)	6	0.00	0.00	6	0.17	0.15	6	0.00	0.00	6	0.50	0.31				6	4.83	1.36	6	5.00	1.37	6	2.17	1.16	6	0.33	0.19
(VI)	6	0.17	0.15	6	0.50	0.46	6	0.00	0.00	6	0.17	0.15	6	0.00	0.00				6	0.67	0.30	6	0.33	0.19	6	0.33	0.19
(VII)	6	0.00	0.00	6	0.00	0.00	6	0.00	0.00	6	0.17	0.15	6	0.17	0.15	6	1.00	0.75				6	0.50	0.31	6	0.33	0.19
(VIII)	6	0.00	0.00	6	0.00	0.00	6	0.00	0.00	6	0.17	0.15	6	0.17	0.15	6	1.00	0.75	6	0.50	0.31				6	0.33	0.19
(IX)	6	0.33	0.19	6	0.33	0.19	6	0.17	0.15	6	0.33	0.19	6	0.33	0.19	6	0.33	0.19	6	0.33	0.19	6	0.33	0.19			

ASC II 2075

	N	AM	SE	N	AM	SE	N	AM	SE	N	AM	SE	N	AM	SE	N	AM	SE	N	AM	SE	N	AM	SE	N	AM	SE
(I)				6	4.83	1.74	6	0.00	0.00	6	1.00	0.75	6	0.33	0.30	6	1.67	0.99	6	0.00	0.00	6	0.00	0.00	6	0.33	0.19
(II)	6	0.33	0.30				6	0.00	0.00	6	0.67	0.45	6	0.17	0.15	6	3.00	1.00	6	0.00	0.00	6	0.00	0.00	6	0.33	0.19
(III)	6	0.00	0.00	6	3.67	1.39				6	0.00	0.00	6	0.50	0.31	6	7.33	0.87	6	6.67	0.99	6	4.67	1.54	6	0.33	0.19
(IV)	6	0.17	0.15	6	3.17	1.54	6	0.00	0.00				6	0.83	0.60	6	7.00	0.88	6	4.00	1.83	6	2.33	1.52	6	0.33	0.19
(V)	6	0.00	0.00	6	0.33	0.30	6	0.00	0.00	6	0.50	0.31				6	5.67	1.45	6	5.67	1.47	6	3.00	1.49	6	0.33	0.19
(VI)	6	0.33	0.30	6	0.67	0.61	6	0.00	0.00	6	0.33	0.30	6	0.00	0.00				6	1.00	0.58	6	0.33	0.19	6	0.33	0.19
(VII)	6	0.00	0.00	6	0.00	0.00	6	0.00	0.00	6	0.17	0.15	6	0.17	0.15	6	1.17	0.89				6	0.50	0.31	6	0.17	0.15
(VIII)	6	0.00	0.00	6	0.00	0.00	6	0.00	0.00	6	0.17	0.15	6	0.17	0.15	6	1.17	0.89	6	0.50	0.31				6	0.17	0.15
(IX)	6	0.33	0.19	6	0.33	0.19	6	0.17	0.15	6	0.33	0.19	6	0.33	0.19	6	0.33	0.19	6	0.33	0.19	6	0.33	0.19			

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Thank you very much for agreeing to support us with your expertise as part of the BioHolz project (www.bioholz-projekt.de)!

The project aims to help preserve the biological diversity of forests and make optimal use of their ecosystem services. The national biodiversity strategy provides the framework, which has been further developed in the biodiversity strategies of the federal states. In the BioHolz project, we are investigating various options for promoting species that are tied to old and dead wood while at the same time meeting the different demands on forests in terms of wood production, regulatory functions and recreation. The Delphi study focuses specifically on the forests in the State of Bavaria.

In this first round of the Delphi process, we would like to ask you to use your expert knowledge and expertise on forests and forestry to make statements about possible future forest development scenarios. The aim is to estimate how Bavaria's forests will develop over a time horizon of 30 or 60 years and which forest forms/forest types may possibly change during this period due to changed framework conditions. Based on this, various scenarios will ultimately be developed that can provide information about potential future forest conditions. You, as a Delphi participant, will be asked about what you think are likely developments, as well as about the changes or developments you prefer.

The aim of this first Delphi round is to gain an overview of the assessments of selected forest experts - including you - on the development of the forests in Bavaria. The results of this round will be sent to you after a statistical and qualitative evaluation and will also serve as the basis for the next, more detailed survey round, which will in turn be addressed to your esteemed address.

1.

1.1 Please rate your **level of knowledge** on the topic of forest condition and development.

very good ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 very bad | no entry ☐

1.2 How would you describe the current situation of the forests in Bavaria in general?

1.3 How familiar are you with the concept of **ecosystem services?**

very familiar ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 not familiar at all | no entry ☐

1.4 Which ecosystem services come to mind when you think of forests?

2.

At this point we would like to introduce you to the following **definition**:

"Ecosystem services refer to direct and indirect contributions of ecosystems to human well-being, that is, services and goods that provide people with direct or indirect economic, material, health or psychological benefits. In contrast to the term ecosystem function, the term ecosystem service arises from an anthropocentric perspective and is linked to the benefits of the ecosystem for humans. The term includes the frequently used terms "ecosystem services" and "ecosystem goods and services" and corresponds to the English term "ecosystem goods and services."
(Source: Natural Capital Germany - TEEB.de)

3.

3.1 Now that you have read a common definition of ecosystem services, would you **change** your original mentions of ecosystem services in relation to forests?

yes	no	don't know	no entry
☐	☐	☐	☐

3.2 If you answered yes to the previous question, which ecosystem services related to forests would you now include or skip?

3.3 Please name the important ecosystem services/functions of deadwood in forests from your perspective.

4.

Please name the **drivers** that, in your opinion, have a significant influence on the current and future development of forests in Bavaria. You can enter up to ten points.

We would then like to ask you to **weight** the drivers you mentioned according to their importance. Please assign numbers from 1 to 10 to the elements

(1 = very important, 10 = unimportant).

4.1 Please explain your ranking in a few sentences.

		yes	no	don't know	no entry
4.2	change **driver 1** (according to ranking) till 2045:	☐	☐	☐	☐
4.3	change **driver 1** (according to ranking) till 2075:	☐	☐	☐	☐
4.4	change **driver 2** (according to ranking) till 2045:	☐	☐	☐	☐
4.5	change **driver** 2 (according to ranking) till 2075:	☐	☐	☐	☐

4.6	change **driver 3** (according to ranking) till 2045:	☐	☐	☐	☐	
4.7	change **driver 3** (according to ranking) till 2075:	☐	☐	☐	☐	
4.8	change **driver 4** (according to ranking) till 2045:	☐	☐	☐	☐	
4.9	change **driver 4** (according to ranking) till 2075:	☐	☐	☐	☐	
4.10	change **driver 5** (according to ranking) till 2045:	☐	☐	☐	☐	
4.11	change **driver 5** (according to ranking) till 2075:	☐	☐	☐	☐	
4.12	change **driver 6** (according to ranking) till 2045:	☐	☐	☐	☐	
4.13	change **driver 6** (according to ranking) till 2075:	☐	☐	☐	☐	
4.14	change **driver 7** (according to ranking) till 2045:	☐	☐	☐	☐	
4.15	change **driver 7** (according to ranking) till 2075:	☐	☐	☐	☐	
4.16	change **driver 8** (according to ranking) till 2045:	☐	☐	☐	☐	
4.17	change **driver 8** (according to ranking) till 2075:	☐	☐	☐	☐	
4.18	change **driver 9** (according to ranking) till 2045:	☐	☐	☐	☐	
4.19	change **driver 9** (according to ranking) till 2075:	☐	☐	☐	☐	
4.20	change **driver 10** (according to ranking) till 2045:	☐	☐	☐	☐	
4.21	change **driver 10** (according to ranking) till 2075:	☐	☐	☐	☐	

*If you answered YES to a driver, how **strong** will the changes be?*

		very strong				very weak	don't know
4.22	Strength of change in driver 1 by 2045:	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐
4.23	Strength of change in driver 1 by 2075:	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐
4.24	Strength of change in driver 2 by 2045:	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐
4.25	Strength of change in driver 2 by 2075:	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐
4.26	Strength of change in driver 3 by 2045:	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐
4.27	Strength of change in driver 3 by 2075:	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐
4.28	Strength of change in driver 4 by 2045:	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐
4.29	Strength of change in driver 4 by 2075:	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐
4.30	Strength of change in driver 5 by 2045:	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐
4.31	Strength of change in driver 5 by 2075:	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐
4.32	Strength of change in driver 6 by 2045:	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐
4.33	Strength of change in driver 6 by 2075:	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐
4.34	Strength of change in driver 7 by 2045:	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐
4.35	Strength of change in driver 7 by 2075:	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐
4.36	Strength of change in driver 8 by 2045:	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐
4.37	Strength of change in driver 8 by 2075:	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐
4.38	Strength of change in driver 9 by 2045:	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐
4.39	Strength of change in driver 9 by 2075:	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐
4.40	Strength of change in driver 10 by 2045:	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐

4.41	Strength of change in driver 10 by 2075:	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5	☐

5.

The drivers you mentioned may have different consequences for different forests. For example, an increased demand for softwood could have a positive effect on the occurrence of coniferous forests but a negative effect on the occurrence of deciduous forests. Based on the current condition of the Bavarian forests and your assessments of future developments, we want to create various scenarios that describe the likely conditions of the Bavarian forests. This should be done with the help of modeling that calculates the spatial distribution of different forms of land use and forest types for the scenarios.

For this purpose, the Bavarian forests are divided into different categories or forest types. The criteria for the classification are intended, on the one hand, to show the most important differences between forests in Bavaria and, on the other hand, to describe as large a proportion of Bavarian forests as possible. At the same time, the number of criteria and the resulting forest types should be as small as possible. We suggest the **following criteria** as a starting point for classifying forest types:

Elevation level	**Main tree species**	**Mixture**	**Age class**	**Deadwood amount**	**Form of ownership**
Hilly Submountainous Mountainous Subalpine	Beech Spruce Pine Oak Other deciduous trees Other coniferous trees	Pure stock (one tree species only) Pure coniferous stock Pure deciduous stock Coniferous with deciduous admixture Deciduous with coniferous admixture 50/50 coniferous-deciduous	< 20 years 20-80 years > 80 years	Classic managed forest Forest with deadwood management measures Near-natural forest	State forest (federal republic) State forest (federal state) Corporation forest Private forest

5.1	Would you have made this classification based on other criteria?	yes ☐	no ☐	don't know ☐	no entry ☐
5.2	If this is the case, which criteria would you also include and/or which would you not take into account? (Please always consider the purpose that the division is intended to fulfill)				
5.3	Do you agree with the rough gradations of the criteria?	yes ☐	no ☐	don't know ☐	no entry ☐
5.4	If not, which gradations would you suggest changing/omitting/adding?				

6.

At this point we would first like to introduce you to the following parameters regarding the current state of the forests in Bavaria:

Selected data from the 2012 Federal Forest Inventory for Bavaria: ·

• Total share of forest in the state area: 35.3%
• Share of coniferous trees in the total forest area: 62.8%
• Share of deciduous trees in the total forest area: 34.9%

• Proportion of areas with a very natural tree species composition in the main vegetation in the state area: 3.9%
• Proportion of areas with a near-natural composition of tree species in the main vegetation in the state area: 11.1%
• Average amount of lying deadwood per hectare: 7.8 m³
• Average amount of standing dead wood per hectare: 6.6 m³
• Average total amount of dead wood (standing, lying, stumps) per hectare: 22.0 m³

*Assuming that the drivers you mentioned remain **constant**: What will the Bavarian forests look like in 2045/2075? Will the above parameters from the BWI change? Please describe the future conditions for the following aspects to us in a few words/key points.*

6.1	Share of forest area in the total area of Bavaria:
6.2	Ratio of deciduous to coniferous trees
6.3	Proportion of near-natural areas in the total forest area:
6.4	Average amount of dead wood (m³ per hectare) in the forests of Bavaria:

The following points also concern changes in general developments.

6.5	Timber production and forest policy:
6.6	Recreational value of the forests in Bavaria:
6.7	Nature conservation measures:
6.8	Amount of threatened animal and plant species/habitats:
6.9	Geographical distribution and spatial connection of forest areas:
6.10	Ownership:
6.11	Would this situation be **desirable** from a current point of view? Please explain your assessment

7.

*Please now assume that there are drivers that will **change** according to your estimates. You can review your assessment by looking at **pages 5 to 8 of the questionnaire**.*
How would the following parameters change in this case? Please describe your assessments in a few words/key points

7.1	Share of forest area in the total area of Bavaria:
7.2	Ratio of deciduous to coniferous trees:
7.3	Proportion of near-natural areas in the total forest area:
7.4	Average amount of dead wood (m³ per hectare) in the forests of Bavaria:
7.5	Timber production and forest policy:
7.6	Recreational value of the forests in Bavaria:
7.7	Nature conservation measures:
7.8	Amount of threatened animal and plant species/habitats:

7.9	Geographical distribution and spatial connection of forest areas:
7.10	Ownership:

What average maximum deadwood volumes do you expect for the following forest categories for the specified time horizons (please provide information in m³ per hectare)?)?

7.11	Unmanaged forests/under protection by 2045:	_____
7.12	Unmanaged forests/under protection by 2075:	_____
7.13	Managed forests by 2045:	_____
7.14	Managed forests by 2075:	_____

7.15	How do you think the amounts of deadwood in Bavaria's forests will change by 2045/2075? Will there be a decrease, stagnation or increase due to adjusted framework conditions? (short explanation)
7.16	In your opinion, what role does the form of ownership (state forest, corporate forest, private forest…) play in future forest development?
8.	
8.1	Please describe to us in a few sentences or bullet points what you think is the **most desirable scenario** for forest development in Bavaria in the period up to 2045/2075. In other words: How would you like the drivers you mentioned to change?
8.2	After you have described your desired development: Which developments do you think should **not** occur or should be avoided in the same period?
8.3	In your opinion, can or should **biodiversity** in Bavaria's forests be increased or not
8.4	If you believe that biodiversity should be increased, what forestry measures do you suggest in this regard?
8.5	How will the **tree species composition** in Bavaria change in the coming decades (until 2075)? Which tree species should be promoted?
9.	
9.1	Are you missing a topic/important aspect in this first round of surveys that **was not sufficiently covered**? If so, why do you think it is relevant to the topic?
10.	

*Finally, we would like to ask you for some **personal information.***

10.1	How old are you?	_____
10.2	What is your gender?	☐ male ☐ female
10.3	What is your institutional affiliation?	_____
10.4	What is your professional position there?	_____
10.5	Please briefly name your current field of activity	_____
10.6	What highest general school qualification do you have?	

☐no degree ☐graduation from elementary school ☐graduation from secondary school
☐graduation from high school ☐no entry

10.7	Do you have a completed university degree?	☐yes ☐no ☐no entry

Questionnaire for the second Delphi round "forest development in Bavaria"

Welcome to the second round of our Delphi survey as part of the BioHolz project!
At this point we would like to thank you again for making your expert knowledge available to us in the first round. This second survey is intended to concretize the results from the first survey. The primary aim will be to evaluate three different forest development scenarios, which were generated based on your assessments, with regard to their probability of occurrence and relevance. In addition, the most common forest types in Bavaria, which were identified taking your suggestions into account, will be examined to determine their likelihood of change.
We would like to ask you to support us again in this round with your assessments and knowledge!

In the first Delphi round, we made suggestions for attributes to categorize (main) forest types in Bavaria and asked you to evaluate them or make suggestions for changes.
By dividing Bavaria's forests into forest types, we would like to make more precise statements about future forest development and the potential changes in individual ecosystem services, depending on the underlying scenario.
Based on your suggestions for classifying forest types, **eight main forest types** for Bavaria were determined based on data from the current federal forest inventory by applying the cluster analysis* method, which are explained in more detail below:

Type 1: Mountain spruce forests*	Mountain and subalpine forests, often dominated by spruce, but always as pure coniferous forest. These forests are often very close to nature and have a very high supply of wood.
Type 2: Mountain mixed forests	Mountain and subalpine forests, often dominated by spruce, always mixed with hardwood. These forests are very close to nature, often part of national parks or nature reserves, rarely privately owned. Fir or Douglas fir are the most common here.
Type 3: Cultivated/non-native spruce (mixed) forests	Sub-mountain forests, often dominated by spruce (or other softwood), often with an admixture of deciduous trees. These forests are always cultivated and usually without fir or Douglas fir.
Type 4: Conditionally near-natural/native spruce (mixed) forests	Sub-mountain forests, dominated by spruce, both in pure conifers and with an admixture of deciduous trees. These forests are partially natural, often single-layered, mostly privately owned and have a very high supply of wood.
Type 5: pine (mixed) forests	Sub-mountain forests, dominated by pine, both in pure conifers and with an admixture of deciduous trees. These forests are partially natural, often have a high supply of wood and fir or Douglas fir are always absent.
Type 6: beech (mixed) forests	Forests dominated by beech, mostly with an admixture of coniferous trees. These forests are often very natural and rarely privately owned.
Type 7: Other lowland deciduous forests	Sub-mountain forests, dominated by other hardwoods and in pure hardwood stands. These forests are often located in protected areas with less stringent protection and often have a high proportion of browsing or peeling damage. They usually have a very low supply of wood and are usually owned by corporations. Fir or Douglas fir are always absent.
Type 8: Other lowland mixed forests	Sub-mountain forests, dominated by other hardwoods and mixed with conifers. These forests often have a very low supply of wood. Fir or Douglas fir are always absent.

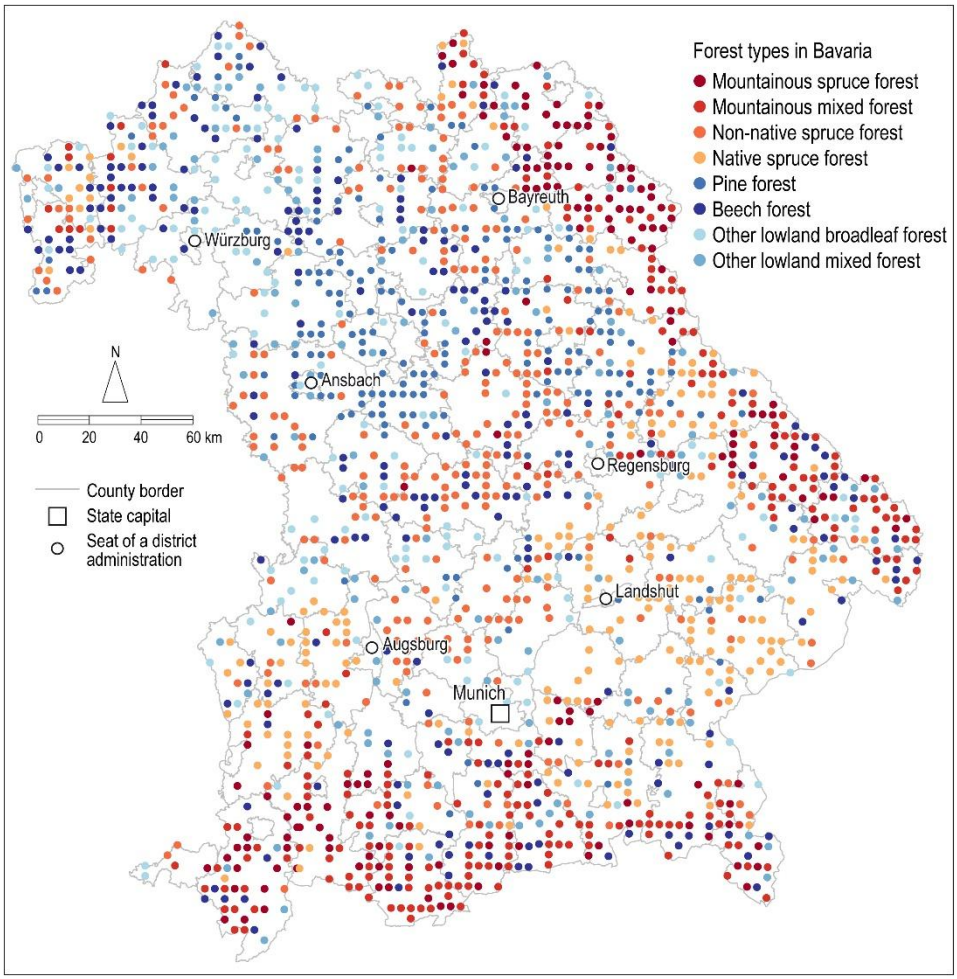
*Background information cluster analysis:
In cluster analysis, observations (in this case the inventory areas of the Federal Forest Inventory) are statistically grouped based on the properties assigned to them. The aim of grouping is to ensure that the inventory areas within a group are more similar than between groups. The following criteria were used to divide the groups:

- Altitude level (hilly, sub-mountainous, mountainous, subalpine)
- Form of ownership (state forest (federal), state forest (state), corporate forest, private forest (up to 20 ha), private forest (>20 ha)
- Main tree species (beech, spruce, pine, other hardwood, other softwood)
- Presence of fir or Douglas fir in the stand
- Mixture (deciduous, coniferous, deciduous with admixture of conifers, conifers with admixture of deciduous)
- Age group (<60 years, 61 - 80, 81 - 120, >120 years)
- Protection status (national parks & nature protection areas: strictly protected; Natura 2000 & flora fauna habitat areas: restricted use; FFH, biosphere, landscape protection areas & nature parks or without protection: no restrictions on management)
- Proportion of trees with peeling or browsing damage during regeneration (no damage, <50% of trees with damage, >49% of trees with damage)

• Wood supply (<200, 200-400, 400-800, >800 m³/ha)
• Close to nature** (close to nature, partially close to nature, emphasizing culture)
• Variety of structures (single-layer, two-layer, multi-layer)

** The definition of closeness to nature follows the Federal Forest Inventory. This defines the proximity to nature according to the proportion of tree species that are part of the natural forest community for the respective location. The proximity to nature can therefore also be interpreted as the suitability of the location: culturally focused = alien to the location / close to nature = appropriate to the location.

The following map of Bavaria shows the spatial distribution of forest types based on the inventory areas from the current federal forest inventory



The eight forest types take up the following percentage shares of the 7,458 inventory points of the Federal Forest Inventory in Bavaria:
Type 1: Mountain spruce forests, 17% (1284 areas)
Type 2: Mixed mountain forests, 14% (1081 areas)
Type 3: Non-native spruce (mixed) forests, 10% (712 areas)
Type 4: Native spruce (mixed) forests, 13% (951 areas)
Type 5: Pine (mixed) forests, 12% (900 areas)
Type 6: Beech (mixed) forests, 11% (841 areas)
Type 7: Other lowland deciduous forests, 15% (1098 areas)
Type 8: Other lowland mixed forests, 8% (591 areas)

A key goal of this second round is to use your assessments to generate probability values for the occurrence of certain developments in Bavaria's forests by 2045 or 2075.
These probability values should ultimately be entered into a scenario generator, which can depict the (spatial) changes in the area of Bavaria's forest types using various statistical simulation models.
In this way, the spatial distribution of forest-based ecosystem services in Bavaria can be shown in terms of their development over time.

1)

At this point we would like to introduce you to the first of three **forest development scenarios** that were generated with the help of your assessments in the first Delphi round. Please read the scenario texts carefully before continuing with the survey. You can also use the same text that was sent to you as a PDF document.

Status quo scenario presented in text form

1a)

Please comment and evaluate in a few sentences the **status quo scenario**, which describes the development of the Bavarian forests under constant drivers, with regard to its plausibility.

1b)

If you would like to change the text of the scenario, you can now suggest changes here:

1c)

Please indicate the probability of the **status quo scenario** on a scale from 0 = "absolutely unlikely" to 10 = "will occur in any case":

2)

In the following section 2, please assume a development according to the **status quo scenario**:

We would first like to ask you to tell us for each individual forest type how its area will change by 2045/2075. Please note that the total area of a forest type can increase even if part of it is converted. For example, 25% of "(mixed) pine forests" could be converted into "(mixed) beech forests", but still grow by 5% overall because, for example, "(mixed) spruce forests from other locations" could be converted into "(mixed) pine forests". being transformed. The same applies to a reverse development.

2a)

Please estimate the percentage of change in area for each forest type. You can use positive and negative values, depending on whether you are assuming an increase or a decrease (please only whole percentages). If you believe that a forest type will not change, please enter 0%.

Example: "Pine (mixed) forests by 2045: 5%" would mean in this case that the area of pine (mixed) forests will increase by a total of 5% by 2045.

	by 2045	by 2075
Type 1: Mountain spruce forests		
Type 2: Mountain mixed forests		
Type 3: Non-native spruce (mixed) forests		
Type 4: Native spruce (mixed) forests		
Type 5: Pine (mixed) forests		
Type 6: Beech (mixed) forests		
Type 7: Other lowland deciduous forests		
Type 8: Other lowland mixed forests		

2b)

Now that you have stated the proportion of change, we would like to ask you to enter **probability values** for conversion to a different forest or use type in the following table. These values can range from **0 = "not at all likely"** to **10 = "extremely likely"**. The current types are listed in rows (letters) and the future types in columns (Arabic numerals).

For example, if "non-native spruce (mixed) forests" would change into "beech (mixed) forests" with a probability of 5 (average probability), then you must enter the number **5** in field **C6**.
(Note: If in the previous question you did not assume any change in the area of a particular forest type, simply leave out all fields in the corresponding line; these will then automatically be counted as 0)

By 2045

	1 (Type 1)	2 (Type 2)	3 (Type 3)	4 (Type 4)	5 (Type 5)	6 (Type 6)	7 (Type 7)	8 (Type 8)	9 (other use)
A (Type 1)									
B (Type 2)									
C (Type 3)									

D (Type 4)									
E (Type 5)									
F (Type 6)									
G (Type 7)									
H (Type 8)									
I (other use)									
By 2075									
	1 (Type 1)	2 (Type 2)	3 (Type 3)	4 (Type 4)	5 (Type 5)	6 (Type 6)	7 (Type 7)	8 (Type 8)	9 (other use)
A (Type 1)									
B (Type 2)									
C (Type 3)									
D (Type 4)									
E (Type 5)									
F (Type 6)									
G (Type 7)									
H (Type 8)									
I (other use)									

2c)

Do you think that under the **status quo scenario**, the probabilities of change in forest type conversion differ between ownership forms? If yes, to what extent?

2d)

Studies have shown that deadwood promotes biological diversity in forests. Assuming that you consider an increase in the proportion of deadwood in forests to be rational: under the **status quo scenario**, which of the forest types do you consider to be particularly suitable for accumulating more deadwood in the future (multiple answers possible)?

Type 1: Mountain spruce forests	
Type 2: Mountain mixed forests	
Type 3: Non-native spruce (mixed) forests	
Type 4: Native spruce (mixed) forests	
Type 5: Pine (mixed) forests	
Type 6: Beech (mixed) forests	
Type 7: Other lowland deciduous forests	
Type 8: Other lowland mixed forests	

2e-g)

In the following three sub-questions we would like to ask you to assess the future development of **deadwood** in Bavaria's forests under the **status quo scenario** for the different forest types.

2e)

The first question is about whether there will be any changes in the (average) amount of deadwood for the forest types. Please tick as appropriate.

	yes	no	don't know	no entry
Type 1: Mountain spruce forests	☐	☐	☐	☐
Type 2: Mountain mixed forests	☐	☐	☐	☐
Type 3: Non-native spruce (mixed) forests	☐	☐	☐	☐
Type 4: Native spruce (mixed) forests	☐	☐	☐	☐
Type 5: Pine (mixed) forests	☐	☐	☐	☐

Type 6: Beech (mixed) forests	☐	☐	☐	☐
Type 7: Other lowland deciduous forests	☐	☐	☐	☐
Type 8: Other lowland mixed forests	☐	☐	☐	☐

2g)

In a final step, please estimate both the maximum and minimum average deadwood volume (in m³ per hectare) for each forest type for which you expect changes under the **status quo scenario** up to 2045 and 2075, respectively.
For example, if you assume that the **average value** of forest type 1 "Mountain spruce forests" will be between a minimum of 2m³/ha and a maximum of 4m³/ha by 2045, then please enter the following in the appropriate field: **2- 4 or 2 to 4.**

(For orientation purposes, the values of the current federal forest inventory are included for each forest type)

	Current average amount according to forest inventory (m³/ha)	Maximum deadwood amount according to forest inventory (m³/ha)	By 2045	By 2075
Type 1: Mountain spruce forests	1.69	59.08		
Type 2: Mountain mixed forests	2.45	82.0		
Type 3: Non-native spruce (mixed) forests	1.13	238.48		
Type 4: Native spruce (mixed) forests	1.02	55.51		
Type 5: Pine (mixed) forests	0.41	31.70		
Type 6: Beech (mixed) forests	2.17	183.35		
Type 7: Other lowland deciduous forests	0.95	55.77		
Type 8: Other lowland mixed forests	1.21	35.90		

2h)

For which form of ownership do you expect greater changes in the amount of deadwood under the **status quo scenario**? Please briefly explain your choice.

2i)

Are there forms of ownership for which you do **not** consider an increase in the amount of deadwood to be realistic under the **status quo scenario**?

3)

Deviating from the status quo scenario, the **alternative scenario I (ASC I)** indicates a possible development that will occur if the drivers influencing forest development change according to your assessments from the first round.

Please read **alternative scenario I** again before continuing to the next section.

Alternative scenario I presented in text form

3a)

Please comment and evaluate in a few sentences the **alternative scenario I**, which describes the development of the Bavarian forests under changing drivers, with regard to its plausibility.

3b)

If you would like to change the text of the scenario, you can now suggest changes here:

3c)

Please indicate the probability of the **alternative scenario I** on a scale from 0 = “absolutely unlikely” to 10 = “will occur in any case”:

4)

In the following section 2, please assume a development according to the **alternative scenario I**:

We would first like to ask you to tell us for each individual forest type how its area will change by 2045/2075. Please note that the total area of a forest type can increase even if part of it is converted. For example, 25% of “(mixed) pine forests” could be converted into “(mixed) beech forests”, but still grow by 5% overall because, for example, “(mixed) spruce forests from other locations” could be converted into “(mixed) pine forests”. being transformed. The same applies to a reverse development.

4a)

Please estimate the percentage of change in area for each forest type. You can use positive and negative values, depending on whether you are assuming an increase or a decrease (please only whole percentages). If you believe that a forest type will not change, please enter 0%.

Example: “Pine (mixed) forests by 2045: 5%” would mean in this case that the area of pine (mixed) forests will increase by a total of 5% by 2045.

	by 2045	by 2075
Type 1: Mountain spruce forests		
Type 2: Mountain mixed forests		
Type 3: Non-native spruce (mixed) forests		
Type 4: Native spruce (mixed) forests		
Type 5: Pine (mixed) forests		
Type 6: Beech (mixed) forests		
Type 7: Other lowland deciduous forests		
Type 8: Other lowland mixed forests		

4b)

Now that you have stated the proportion of change, we would like to ask you to enter **probability values** for conversion to a different forest or use type in the following table. These values can range from **0 = “not at all likely”** to **10 = “extremely likely”**. The current types are listed in rows (letters) and the future types in columns (Arabic numerals).

For example, if “non-native spruce (mixed) forests” would change into “beech (mixed) forests” with a probability of 5 (average probability), then you must enter the number **5** in field **C6**.
(Note: If in the previous question you did not assume any change in the area of a particular forest type, simply leave out all fields in the corresponding line; these will then automatically be counted as 0)

By 2045

	1 (Type 1)	2 (Type 2)	3 (Type 3)	4 (Type 4)	5 (Type 5)	6 (Type 6)	7 (Type 7)	8 (Type 8)	9 (other use)
A (Type 1)									
B (Type 2)									
C (Type 3)									
D (Type 4)									
E (Type 5)									
F (Type 6)									
G (Type 7)									
H (Type 8)									
I (other use)									

By 2075

	1 (Type 1)	2 (Type 2)	3 (Type 3)	4 (Type 4)	5 (Type 5)	6 (Type 6)	7 (Type 7)	8 (Type 8)	9 (other use)
A (Type 1)									
B (Type 2)									
C (Type 3)									
D (Type 4)									
E (Type 5)									
F (Type 6)									
G (Type 7)									
H (Type 8)									
I (other use)									

4c)

Do you think that under the **alternative scenario I**, the probabilities of change in forest type conversion differ between ownership forms? If yes, to what extent?

4d)

Studies have shown that deadwood promotes biological diversity in forests. Assuming that you consider an increase in the proportion of deadwood in forests to be rational: under the **alternative scenario I**, which of the forest types do you consider to be particularly suitable for accumulating more deadwood in the future (multiple answers possible)?

Type 1: Mountain spruce forests	
Type 2: Mountain mixed forests	
Type 3: Non-native spruce (mixed) forests	
Type 4: Native spruce (mixed) forests	
Type 5: Pine (mixed) forests	
Type 6: Beech (mixed) forests	
Type 7: Other lowland deciduous forests	
Type 8: Other lowland mixed forests	

4e-g)

In the following three sub-questions we would like to ask you to assess the future development of **deadwood** in Bavaria's forests under the **alternative scenario I** for the different forest types.

4e)

The first question is about whether there will be any changes in the (average) amount of deadwood for the forest types. Please tick as appropriate.

	yes	no	don't know	no entry
Type 1: Mountain spruce forests	☐	☐	☐	☐
Type 2: Mountain mixed forests	☐	☐	☐	☐
Type 3: Non-native spruce (mixed) forests	☐	☐	☐	☐
Type 4: Native spruce (mixed) forests	☐	☐	☐	☐
Type 5: Pine (mixed) forests	☐	☐	☐	☐
Type 6: Beech (mixed) forests	☐	☐	☐	☐
Type 7: Other lowland deciduous forests	☐	☐	☐	☐
Type 8: Other lowland mixed forests	☐	☐	☐	☐

4g)

In a final step, please estimate both the maximum and minimum average deadwood volume (in m^3 per hectare) for each forest type for which you expect changes under the **alternative scenario I** up to 2045 and 2075, respectively.

For example, if you assume that the **average value** of forest type 1 "Mountain spruce forests" will be between a minimum of 2m³/ha and a maximum of 4m³/ha by 2045, then please enter the following in the appropriate field: **2- 4 or 2 to 4.**

(For orientation purposes, the values of the current federal forest inventory are included for each forest type)

	Current average amount according to forest inventory (m³/ha)	Maximum deadwood amount according to forest inventory (m³/ha)	By 2045	By 2075
Type 1: Mountain spruce forests	1.69	59.08		
Type 2: Mountain mixed forests	2.45	82.0		
Type 3: Non-native spruce (mixed) forests	1.13	238.48		
Type 4: Native spruce (mixed) forests	1.02	55.51		
Type 5: Pine (mixed) forests	0.41	31.70		
Type 6: Beech (mixed) forests	2.17	183.35		
Type 7: Other lowland deciduous forests	0.95	55.77		
Type 8: Other lowland mixed forests	1.21	35.90		

4h)

For which form of ownership do you expect greater changes in the amount of deadwood under the **alternative scenario I?** Please briefly explain your choice.

4i)

Are there forms of ownership for which you do **not** consider an increase in the amount of deadwood to be realistic under the **alternative scenario I**?

5)

After the status quo and the alternative scenario I, we would like to introduce you to a third possible development, the **alternative scenario** II (ASC II).

Alternative scenario II presented in text form

5a)

Please comment and evaluate in a few sentences the **alternative scenario II**, which describes the development of the Bavarian forests under changing drivers, with regard to its plausibility.

5b)

If you would like to change the text of the scenario, you can now suggest changes here:

5c)

Please indicate the probability of the **alternative scenario II** on a scale from 0 = “absolutely unlikely” to 10 = “will occur in any case”:

6)

In the following section 2, please assume a development according to the **alternative scenario II**:

We would first like to ask you to tell us for each individual forest type how its area will change by 2045/2075. Please note that the total area of a forest type can increase even if part of it is converted. For example, 25% of "(mixed) pine forests" could be converted into "(mixed) beech forests", but still grow by 5% overall because, for example, "(mixed) spruce forests from other locations" could be converted into "(mixed) pine forests". being transformed. The same applies to a reverse development.

6a)

Please estimate the percentage of change in area for each forest type. You can use positive and negative values, depending on whether you are assuming an increase or a decrease (please only whole percentages). If you believe that a forest type will not change, please enter 0%.

Example: "Pine (mixed) forests by 2045: 5%" would mean in this case that the area of pine (mixed) forests will increase by a total of 5% by 2045.

	by 2045	by 2075
Type 1: Mountain spruce forests		
Type 2: Mountain mixed forests		
Type 3: Non-native spruce (mixed) forests		
Type 4: Native spruce (mixed) forests		
Type 5: Pine (mixed) forests		
Type 6: Beech (mixed) forests		
Type 7: Other lowland deciduous forests		
Type 8: Other lowland mixed forests		

6b)

Now that you have stated the proportion of change, we would like to ask you to enter **probability values** for conversion to a different forest or use type in the following table. These values can range from **0 = "not at all likely"** to **10 = "extremely likely"**. The current types are listed in rows (letters) and the future types in columns (Arabic numerals).

For example, if "non-native spruce (mixed) forests" would change into "beech (mixed) forests" with a probability of 5 (average probability), then you must enter the number **5** in field **C6**.
(Note: If in the previous question you did not assume any change in the area of a particular forest type, simply leave out all fields in the corresponding line; these will then automatically be counted as 0)

By 2045

	1 (Type 1)	2 (Type 2)	3 (Type 3)	4 (Type 4)	5 (Type 5)	6 (Type 6)	7 (Type 7)	8 (Type 8)	9 (other use)
A (Type 1)									
B (Type 2)									
C (Type 3)									
D (Type 4)									
E (Type 5)									
F (Type 6)									
G (Type 7)									
H (Type 8)									
I (other use)									

By 2075

	1 (Type 1)	2 (Type 2)	3 (Type 3)	4 (Type 4)	5 (Type 5)	6 (Type 6)	7 (Type 7)	8 (Type 8)	9 (other use)
A (Type 1)									
B (Type 2)									
C (Type 3)									
D (Type 4)									
E (Type 5)									
F (Type 6)									
G (Type 7)									

H (Type 8)									
I (other use)									

6c)

Do you think that under the **alternative scenario II**, the probabilities of change in forest type conversion differ between ownership forms? If yes, to what extent?

6d)

Studies have shown that deadwood promotes biological diversity in forests. Assuming that you consider an increase in the proportion of deadwood in forests to be rational: under the **alternative scenario II**, which of the forest types do you consider to be particularly suitable for accumulating more deadwood in the future (multiple answers possible)?

Type 1: Mountain spruce forests	
Type 2: Mountain mixed forests	
Type 3: Non-native spruce (mixed) forests	
Type 4: Native spruce (mixed) forests	
Type 5: Pine (mixed) forests	
Type 6: Beech (mixed) forests	
Type 7: Other lowland deciduous forests	
Type 8: Other lowland mixed forests	

6e-g)

In the following three sub-questions we would like to ask you to assess the future development of **deadwood** in Bavaria's forests under the **alternative scenario II** for the different forest types.

6e)

The first question is about whether there will be any changes in the (average) amount of deadwood for the forest types. Please tick as appropriate.

	yes	no	don't know	no entry
Type 1: Mountain spruce forests	☐	☐	☐	☐
Type 2: Mountain mixed forests	☐	☐	☐	☐
Type 3: Non-native spruce (mixed) forests	☐	☐	☐	☐
Type 4: Native spruce (mixed) forests	☐	☐	☐	☐
Type 5: Pine (mixed) forests	☐	☐	☐	☐
Type 6: Beech (mixed) forests	☐	☐	☐	☐
Type 7: Other lowland deciduous forests	☐	☐	☐	☐
Type 8: Other lowland mixed forests	☐	☐	☐	☐

6g)

In a final step, please estimate both the maximum and minimum average deadwood volume (in m^3 per hectare) for each forest type for which you expect changes under the **alternative scenario II** up to 2045 and 2075, respectively. For example, if you assume that the **average value** of forest type 1 "Mountain spruce forests" will be between a minimum of 2m^3/ha and a maximum of 4m^3/ha by 2045, then please enter the following in the appropriate field: **2- 4 or 2 to 4.**

(For orientation purposes, the values of the current federal forest inventory are included for each forest type)

	Current average amount according to forest inventory (m^3/ha)	Maximum deadwood amount according to forest inventory (m^3/ha)	By 2045	By 2075
Type 1: Mountain spruce forests	1.69	59.08		

Type 2: Mountain mixed forests	2.45	82.0		
Type 3: Non-native spruce (mixed) forests	1.13	238.48		
Type 4: Native spruce (mixed) forests	1.02	55.51		
Type 5: Pine (mixed) forests	0.41	31.70		
Type 6: Beech (mixed) forests	2.17	183.35		
Type 7: Other lowland deciduous forests	0.95	55.77		
Type 8: Other lowland mixed forests	1.21	35.90		

6h)

For which form of ownership do you expect greater changes in the amount of deadwood under the **alternative scenario II**? Please briefly explain your choice.

6i)

Are there forms of ownership for which you do **not** consider an increase in the amount of deadwood to be realistic under the **alternative scenario II**?

7)

Independently of the three forest development scenarios, please assume that responsible stakeholders agree to increase the proportion of deadwood in Bavaria's forests in order to support or secure biological diversity. The increase can be accomplished in different ways.
In this context, which of the following strategies do you consider to be the **most likely** to be implemented and which do you **personally consider** to be **useful**? (Please rank the options as follows: "1" = main strategy*; "2", "3", "4", "5" = secondary strategies if higher-level strategies are not possible; "0" = not a realistic option)

*The term "main strategy" is intended to describe the measure that is mainly used to enrich deadwood

- "Whole tree" variant (whole trees are not used) probable strategy sensible strategy
- "Earth trunk" variant (section at the strong end of the trunk with a mean diameter of at least 40 cm is left lying)
- "Small wood" variant (industrial wood or logs with a mean diameter of a maximum of 20 cm are not used)
- "Crown wood" variant (crown material from the selected processing area (e.g. all wood with a diameter of less than 10 cm) is left in the existing stock instead of being processed into wood chips, for example)
- Different variant

Please briefly describe the different variant

8)

Do you have any suggestions for this round or was there an important aspect missing?

Finally, we would like to thank you very much for once again taking the time to support us in our research work!

As soon as the results of this round have been evaluated, you will receive them from us.