



ANNUAL REPORT 2017



FVA

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FOREWORD



Dear Reader,
The scientific congress, on the occasion of the 125th Anniversary of the International Union of Forest Research Organizations IUFRO, was one of the most important activities for the FVA in 2017, but also during a few years earlier. So, according to the slogan "good things come to those who wait" the Congress in September 2017 in Freiburg was enormously successful with more than 2,000 participants. In regard to this, the FVA did not only engage in organizing this Congress, but numerous scientists from all FVA departments also contributed to the success of the Congress – through oral and poster presentations, through organizing post-congress-excursions or through organizing sessions on their own research field. The Congress particularly addressed the two most challenging topics for the forestry and interdisciplinary research – globalization and climate change that must be faced jointly and across boundaries.

The diverse and future-oriented research of the FVA resulted in numerous scientific publications, presentations in national and international scientific congresses, as well as putting their research into practice. FVA employees also published their results in practice-oriented journals, organized many workshops and advanced training courses with high practical relevance during the year 2017. They were involved in political consulting and policy advising and participated in counselling meetings, Forest Days and trade fairs, as well as representing the FVA in different workgroups and committees. Furthermore, the media showed an increased interest in current research topics of the FVA, particularly lynx, wolves and social topics such as recreational activities in the forest, digitalisation within the forest, forest health, pests, impacts of climate change on the forest, future tree species, biodiversity and sustainable forest management.

The current Annual Report gives a brief overview of the achievements and activities of the FVA in 2017. Moreover, a selection of research projects is presented in more detail, including essential facts and figures of the previous year.

I hope you will enjoy reading through our Annual Report and of course discover a thing or two in the various activities of the FVA.

Yours sincerely,

A handwritten signature in black ink, which appears to read "K. v. Teuffel".

Prof. Konstantin von Teuffel
Director



FROM THE ADVISORY BOARD

Dear Reader,
Organizing the 125th Anniversary Celebration of the International Union of Forest Research Organizations IUFRO 2017 in Freiburg was formative for the FVA, as well as for the activities of the Advisory Board, which also participated in this well-attended event. The Advisory Board recommended that the FVA presents the contribution of its national research activities in Europe and across the continent through the media as part of their preparation for the congress. The Advisory Board members are delighted that their advice to enter into a contract with a nationwide public relations (PR) agency was implemented by the FVA. As a result, regional and nationwide press as well as radio and television reported about German forest research and the international congress.

This year, the recently developed principles of FVA's data policy were presented to the Advisory Board. All members of the Board appreciated this short, clear and concise paper. Even though implementing its content was regarded as a

big challenge for the future, this first step showed the right direction for beginning to develop experience using the policy.

The Advisory Board has already dealt in detail with the process of a new strategy for the FVA. Even though the contents of a new FVA strategy will not be defined before the key points of the currently on going reform of the State Forest Service have been fixed, the Board presented some preliminary suggestions for the process and contents of the new FVA strategy. In this context, the Advisory Board considers that a strategy with a stronger external focus would enable the FVA to respond to actual needs with a greater benefit. Therefore, it would be advisable to involve ministerial departments, similar institutions, private and communal forest owners, nature conservation and the timber industry to the process through questionnaires and/or workshops. In addition, the Board recommended that the FVA analyses its core competencies during the strategic development process. For this, it seems necessary to determine what the FVA is already doing



Photo T. Weidner

The Advisory Board at work

well - what activities should be retained and what activities will gain in importance. What do new target groups want? The Advisory Board still considers the long-term ecological monitoring as a core competency of the FVA, as well as applied research, advisory service and knowledge transfer. Moreover, research priorities should reflect demand; topics like forest utilisation, biodiversity, climate change and forest health will remain important. In addition, the Board thinks that bio-economy and tourism research in the forest are going to become more important in the future.

At the autumn meeting of the Advisory Board the annual plan was presented as a basis for the work program of the FVA and approved by the Board Members. At this meeting, the term of the current Advisory Board ended. Consequently, three members left the Board after 8 years of membership. On behalf of all Board members, I would like to express my warmest thanks for the open, constructive and very friendly

discussions to Prof. Dr. James Kirchner (ETH Zurich), Prof. Dr. Bernhard Möhring (Göttingen University) and Prof. Dr. Jürgen Bausch (Freiburg University), who all successfully enriched the Advisory Board through their knowledge and contributions.

As soon as the new Advisory Board is formed, I greatly appreciate the next opportunity for an exchange between the Advisory Board and the employees of the FVA during the upcoming autumn.

Dr. Peter Mayer
Chairman of the Advisory Board



THE YEAR 2017 IN REVIEW

KONSTANTIN VON TEUFFEL, KAISU MAKKONEN-SPIECKER
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Mixed forests are increasingly becoming the focus of political attention. Alternatives are being sought, particularly for spruce, a tree for which in many locations the forecasted survival outlook is poor because of climate change. For over 20 years, near-natural silviculture has been the guideline for managing the forests of Baden-Württemberg, which becomes evident as spruce declines when beech and other broad leaves are favoured. The FVA is also oriented in that direction with its cross-departmental research focus on biodiversity: The near-natural state of the composition of tree species in the state forest is modelled; selection of target species aimed at species conservation is accelerated on a scientific basis; the “old and dead wood concept” is being evaluated to determine the development of the biological diversity; species conservation in the forest based on the concept for preservation and restoration of open site forests is promoted; and in the Regional Nature Reserve Schwetzingen Hardt, the pokeweed is being eradicated – just to name some of the topics of this biodiversity research. With the growing importance of broad leaved forests, the innovative use of hardwoods is also intensified in FVA research. However, this also brings up questions regarding silviculture and forest economics. .

Wanted: Tree Species for the Future

Even though the results of the yearly State-of-the-Forest Report are not alarming for 2017 - the condition of the forests in Baden-Württemberg has slightly improved compared to the previous year - research about the consequences of climate impact remains an important focus, which the FVA addresses across departments. Within this framework, tree species vitality in climate change conditions is also examined, models are developed to support decision-making and medium to long term alternative tree species and provenances are investigated. Given the fact that all the main current tree species are suffering because of climate change and are deteriorating, in the long run, an extensive literature-based collection of profiles for 25 tree species was put together in the search for “tree species of the future”. The species profiles contain information about the prioritised criteria for distribution and ecology, the link with habitat, stocking, performance, wood characteristics and wood usage, other ecosystem functions, biotic and abiotic risks and the experiences with these species so far, as well as about their indicators. This collection of information has been published recently (see the article on page 16).



Photo T. Weidner

Visiting the FVA: State Secretary Friedlinde Gurr-Hirsch and Member of Federal Parliament Reinhold Pix (in the middle) with Konstantin von Teuffel (left) and Udo Hans Sauter

W+ Growth Simulator

The FVA has developed the W+ growth simulator as a tool for decision making when treating forest stands. Currently, it has been parametrised for spruce, Douglas fir and beech monocultures. The parameterizing is based on data from FVA treatment trials; the main focus of which lies on the future tree-oriented selection thinning of various intensities. However, the data also include thinning from below, growing stock maintenance and various final cutting strategies, so that a broad spectrum of silvicultural measures can be planned.

A special methodical feature of the simulator is the ability to estimate diameter and basal area growth. It uses a process based on a combination of single tree and forest stand models. It enables us to significantly improve forecast accuracy as compared to simpler estimation methods. An important guideline for developing the simulator was that it could also be used by forest practitioners and therefore the input data needed to be readily available and easily attainable in practice. Just a few parameters, such as the basal area or the number of trees and average stand diameter, as well as age and top height, suffice to use the programme; but optionally, diameter and height distribution can also be entered. Despite not needing much data, the W+ provides very reasonable simulation results.

Forests in the Digital Age

Digitalisation is no longer just a political topic. It has also reached the forests and will be both a challenge and an opportunity in the future. Innovative technologies for recording, charting and digitalising important forest and tree parameters enable us to better and more accurately face climate change induced alterations in forests and provide for a more rapid response. Tests are currently being carried out to show how drone photos of the forest canopy can help us measure whether and to what extent a stand is damaged. Applications for optimizing road networks or identifying important elements in the habitats of rare animals are also possible. The FVA will increasingly pursue this theme within its research work.

In media reporting on the congress of the IUFRO (International Union of Forest Research Organisations) in Freiburg, the topic “Forest in the Digital Age” also took centre stage. Various daily newspapers, radio broadcasts and the main news programme of German broadcasting channel ZDF reported on the use of drones and digitalisation in forest research. However, even though digitalisation affects many areas of forest research, it could not top the all-encompassing diversity of forest themes at the congress, captivated in its motto “Connecting Forest, Science and People”. The latest forest research insights were contained in over 1,800 contributions (see the article on page 13).



Photo H. Arnold

Tagging of "Thekla vom Kreuzle": (front) Steffi Thoma and Max Kröschel, (behind) Forest Ranger Mr. Thomas



Photo T. Weidner

Science Day at Freiburg: (left) Jörg Kleinschmit



Photo S. Thoma

Forest Day at Kaltenbrunn: (left) Dominik Fechter



Photo T. Weidner

Talking with FVA employees: Ministerial Director Grit Puchan (in the middle) and Ministerial Counsellor Sibylle Werner (right)

The Return of the Wolf

Another topic that was much discussed beyond the borders of Baden-Württemberg in 2017 was new detections of wolves in the state. This became a political topic when in July, a shot wolf was found in Schluchsee lake in the Black Forest and the police started a criminal inquiry against unknown perpetrator(s). The debate was fuelled by the first farm animals found dead in the autumn of 2017 in the district of Heilbronn and in Calw, evidently killed by a wolf. Additionally, captured wild animals were found in the Northern Black Forest. Again and again, FVA got involved in the discussions, as the organisation has been tasked to monitor wolves in Baden-Württemberg by the Ministry of Environment.

As a result of wolf monitoring, the FVA was able to confirm the following wolf detections in Baden-Württemberg up until the end of 2017: two male yearlings from Switzerland, killed by a car crash in 2015, a wolf of unknown origin in 2016,

a wolf from Lower Saxony in July 2017 that was sighted in various places in the southwest during its wanderings and finally was retrieved from the Schluchsee lake, as well as a wolf of unknown origin that killed three sheep near Widdern in the Heilbronn district, early October. Finally, further killings of farm animals and deer were recorded since the end of November: Three sheep near Bad Wildbad and a deer killing near Bad Rippoldsau-Schwappach were clearly attributed to the same wolf from Lower Saxony. The FVA assumes that the same male wolf is responsible for another deer killing at end of November, north of Freudenstadt near Simmerfeld, as well as for killing a sika deer in the same area. A photograph of a wolf, apparently taken on Christmas day near Vöhrenbach, Black Forest, could thus far only be confirmed as a wolf sighting, but not as evidence, as the photographer could not yet be contacted.

The return of the wolf was also the topic at the public hearing of the state parliament on October 26th, to which Rudi Suchant, researcher at FVA, working section of wildlife management, was invited to report on the wolf monitoring

programme. In addition, a controversial discussion is taking place about whether the wolf should be included in the Law on Hunting and Wildlife Management.

Forest Leisure Activities versus Wildlife

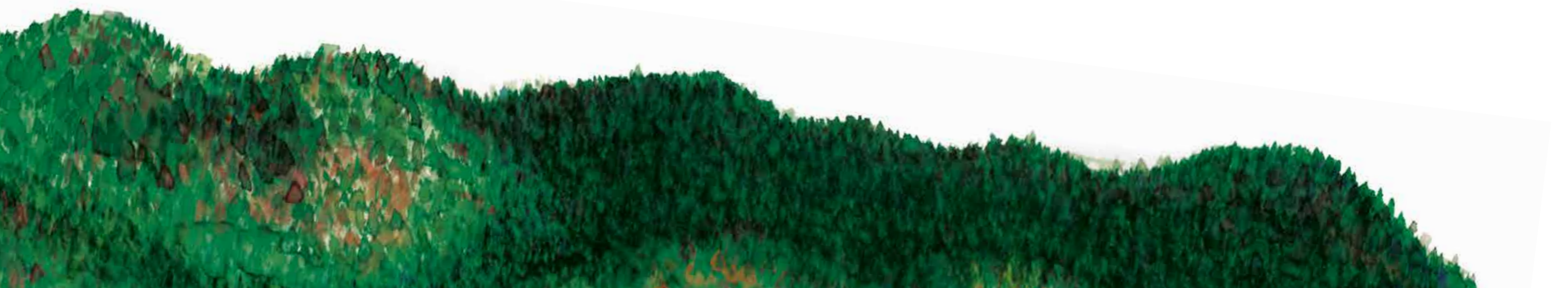
Increasingly, conflicts in the forests do not only arise from encounters between various outdoor sport enthusiasts, be they on foot or on their mountain bikes. The increasing amount and diversity of leisure activities in forests - even after dark, off-track and in remote areas - are a cause of stress for wildlife: Their opportunities to retreat are being infringed upon, in terms of both time and space. They find less and less quiet areas without human encounters. The influence of hunting and its interactions with other leisure activities are posing new challenges for wildlife management. At the 6th Denzlinger Wildlife Forum in March this year, these conflict areas were thematically addressed - and as usual, the event was highly attended with about 300 interested people from various fields of expertise. The impact of human leisure activities on the behaviour

of wood grouse and red deer is also discussed on page 24.

Recreational Forest Remapped

Recreational forest mapping is part of forest function mapping and serves specialized authorities with a tool for forest conservation and specialist planning. Redefinition was required because previous data were outdated. In 2017, the FVA completed the recreational forest remapping project. In the process, a new methodology was developed for the demarcation of recreational forests on a scientific basis. The process was developed in collaboration with the Chair of Forest and Environmental Politics of Freiburg University. The Swiss Federal Institute for Forest, Snow, and Landscape Research (WSL) also participated in the project. The FVA has introduced this new process in the scientific community nationally and internationally, thus bringing it into a scientific discussion.

In a recently started EU project in which the FVA participates, forest ecosystem services will be mapped and their economic value determined.



125 YEARS IUFRO - A JUBILARIAN FULL OF VITALITY

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Fieldtrip to view peat bog conservation

Photo J. Raddatz



Congratulating IUFRO on its anniversary: IUFRO - President Mike Wingfield (left) and FVA Director Konstantin von Teuffel

Photo K. Polkowski

Moors as Carbon Stores

As climate changes, moors are increasingly becoming noticed as reservoirs for carbon. Moor protection is also a focus point of the nature conservation strategy for Baden-Württemberg. Baden-Württemberg and Bavaria are currently developing, with participation from the FVA, a joint "Moor Protection Manual" that will be published shortly. In April last year, four state institutes from Baden-Württemberg and Bavaria jointly organised a conference on the Protection of moors in Southern Germany: the FVA, the State Institute for Environment Baden-Württemberg (LUBW), the Bavarian Environmental Protection Office (LfU) and the Bavarian State Institute of Forestry (LWF). The conference focused on the importance of moors for climate and species conservation, the sustainable exploitation of moors and the development of new approaches for moor protection. The public was very

diversified: around 140 representatives from ministries in Baden-Württemberg and Bavaria, regional politics, official nature protection bodies, official authorities on land, forest and water management, planning offices and the sectors of nature conservation, land and forest management and tourism.

A cross-state excursion to the "Schorenmoos" in Bavaria and the "Wurzacher Ried" reedy marshlands in Baden-Württemberg following the conference day provided deeper insight into the themes of the conference with practical examples regarding preservation and rewetting of moorlands. This activity allowed for the building of a framework for further exchanges of experiences and discussions.

The following pages contain brief presentations of research findings from selected FVA projects. Information about other projects and about further FVA activities can be found on www.fva-bw.de.

From the 18th to the 22nd of September 2017, over 2,000 scientists from more than 100 countries and from every continent, as well as representatives from the world of politics, business and non-governmental organisations came to Freiburg to celebrate the 125th Jubilee of the International Union of Forest Research Organisations, IUFRO. Prior to the event, the organising committee had already decided to extend the congress by one day, when well over 3,000 scientists, either individually or in teams, responded to the appeal to submit summaries for presentations. Nevertheless, in the first preparation phase, a maximum of 800 to 1,000 participants were expected. The organiser of the congress was the forest research network in the three-country border triangle, NFZ.forestnet, a collaboration between the

research institutes from Nancy, Freiburg and Zürich. The FVA was appointed to chair the organisation.

The Federal Ministry of Food and Agriculture (BMEL), the Ministry of Rural Affairs and Consumer Protection Baden-Württemberg (MLR), the Ministry for a Livable Austria, the Swiss Federal Office for Environment, French research partners and the IUFRO provided financial and material support for the congress. On the one hand, this made it possible to invite top-level and internationally renowned scientific and political keynote speakers. On the other hand, a BMEL supported scholarship programme enabled scientists from poorer countries to participate in the congress.

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The organizing committee of the IUFRO congress (from left):

Erwin Dreier (INRA)
 Thomas Haufmann (BMEL),
 Alexander Buck (IUFRO)
 Sibylle Werner (MLR)
 Konstantin v. Teuffel (FVA)
 Helen Desmond (FVA)
 Jean-Pierre Jaquot
 (Université Lorraine)
 Janina Radny (FVA)
 Jean-Luc Peyron (GIP - Ecofor)
 Kristine Haberer (WSL)
 Andreas Rigling (WSL)
 Christoph Vogt (MLR)

Photo T. Weidner



Tree planting with professional support of Manuel Karopka, FVA (from the left): IUFRO - President Mike Wingfield, City Mayor of Freiburg Dieter Salomon and FVA - Vice Director Gerald Kändler

Photo K. Mäkeläinen-Spricker

Why in Freiburg?

In the three-country border triangle, Freiburg offered the right setting for the congress: Not only because the Association of German Forest Research Institutes - including the institutes that preceded the FVA, the Forest Research Institutes of Baden and Württemberg - as well as the research institutes in Austria and Switzerland were founders of the IUFRO, but also because practically oriented forest research (FVA) meets fundamental forest research (the Faculty for Environment and Natural Resources) in Freiburg. Additionally, the geographic location in the border triangle made it possible to organise half and full day excursions into the most diverse landscapes, from the Rhine Valley to the Black Forest, and from the Vosges to the Swiss Jura, so that following the congress a broad spectrum of different forest topics relevant to central Europe, and miscellaneous landscapes could be presented.

A broad range of topics and prominent personalities

The range of forest topics at the congress presented in over 1,800 scientific contributions, were almost all-encompassing. The themes ranged from forests under climate change, forest products, diversity of species, ecosystem services,

invasive species, interaction between forest, soil and water, forest management technology, forest management, forest condition assessment, modelling, forest health and forest policy to the social aspects of forests and forestry. The international audience was introduced to current results of long-term international research projects and the work of young scientists and these topics were discussed cross-culturally and across disciplines. Moreover, scientists from all FVA departments were present giving multiple papers and poster presentations or they organised sessions on their subject area.

Besides the very well attended, purely scientific parallel sessions, there were also a number of plenary sessions, "Science in Dialogue", to discuss the future roll of the IUFRO and the forest sciences with the various international advocacy groups, such as the United Nations (UN), the Food and Agriculture Organization (FAO), the World Bank and the World Wide Fund for Nature (WWF). Prominent personalities such as the former Prime Minister of Sweden, Göran Persson, provided the introduction to the panel discussions. The plenary sessions were broadcasted live and can be viewed via www.iufro2017.com.

The congress also enabled exchanges, both formal and informal, in the IUFRO work groups and international networks. Furthermore, a scientific framework programme was proposed, as well as three training courses and seven summer academies for doctoral candidates.

A lime tree to commemorate 125 years of IUFRO

Within the framework of the congress, the traditional IUFRO tree planting took place in the front garden of the Faculty of Environment and Natural Resources. The lime tree was chosen to symbolize the socio-cultural connection between forest and people in German-speaking central Europe, where the founding fathers of IUFRO came from. It also serves as a memory of the IUFRO congress in Freiburg. After the tree planting, an artistic forest history exhibition, "125 year of IUFRO", was opened in the inner courtyard of the faculty. This exhibition was the result of a collaboration between forest scientists and art students.

IUFRO today - A cross-border approach to tackling global environmental problems

With its headquarters established in Vienna in 1973, the IUFRO is the only global network involved in forest research and related disciplines. As early as time of IUFRO's formation, 125 years ago, it was of fundamental importance that many forest and environmental problems could only be solved through international, cross-border collaboration and that the appropriate measures required the most up-to-date scientific insights, as the Deputy Executive Director of the IUFRO, Dr. Michael Kleine, described IUFRO's role. According to him, in view of global challenges such as climate change and the rapidly growing world population, this recognition is more important today than ever before.

Today, approximately 650 organisations in 126 countries are members of the IUFRO. Germany alone numbers 41 member organisations. The organisation represents over 15,000 scientists worldwide. The next major IUFRO event, the 25th World Congress, will take place in 2019, in Curitiba, Brazil. It will be the first time in the history of the IUFRO that the event will be held in Latin-America.

CLIMATE CHANGE RESEARCH

AXEL ALBRECHT, ANGELA DE AVILA | Dept. of Forest Growth | axel.albrecht@forst.bwl.de



In 2010 FVA published the first digital maps of tree species suitability under climate change. The dynamic climatic component of those maps was based on results of climate-sensitive species distribution models (Hanewinkel et al., 2010; Hanewinkel et al., 2014). Now, we calculated the state-wide changes predicted by those maps and found systematically decreasing suitability for all four main tree species.

Decreasing climatic suitability of main tree species is driving the search for alternatives

For Norway spruce, the decrease consisted mainly of an increase in the share of the least suitable classes (red bars), while for European beech, Silver fir and sessile oak the global decrease was mainly driven by a decrease in the best suitability classes (green bars).

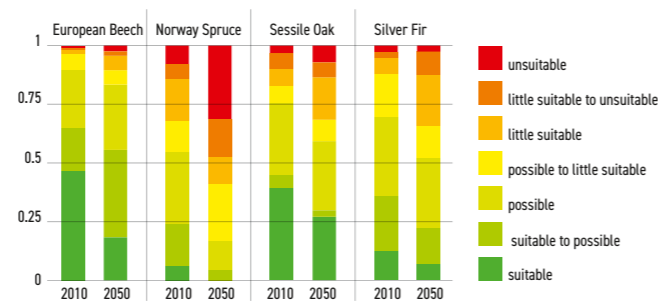


Figure 1: State-level trends in climatic site suitability of the main tree species in Baden-Württemberg (BW) under climate change until 2050. Climatic scenario: SRES B2 (IPCC, 2000).

Acknowledging that this result is only valid for the (by now) unrealistically optimistic climate scenario B2, and that climatic changes were only considered until 2050, while climatic changes are likely to become even more pronounced in the second half of the 21st century (see for example figure SPM 7a, in source IPCC, 2013), we have to deduce the quite urgent necessity to search for better suited alternatives. Although it is not likely that we will be facing drastic forest mortality and total losses of these tree species in the sense of the „Waldsterben“ (forest decline) discussion of the 1980s, our results reveal the clear trends of decreasing climatic suitability.

Next step: briefing papers on alternative tree species

To organize the necessary search for alternative tree species systematically, we began with a literature review. We compiled available literature knowledge concerning the ecology, the cultivation, associated risks, and potential yield and wood utilization into briefing papers of potential alternative tree species using about four pages per species. Special emphasis was on

- a broad search radius, leading to the description of a set of 25 species,
- a condensed presentation form, and
- a rapid publication of the briefing papers.

Based on conceptual considerations, three categories of species were distinguished: (1) native species which are today rare species due to their currently low competitive ability may potentially gain competitiveness in future climatic suitability. Non-native tree species showing good climatic suitability for the future climate in Baden-Württemberg belong to the group of climate-analogous tree species. The analogy aspect in this group lies in the conformance between today's climate in the region of origin of the species and the future climate that is expected in Baden-Württemberg. This group is subdivided into (2) European and (3) non-European tree species. The delineation between today's natural distribution of the European and non-European species was not always straight-forward and should thus not be over interpreted. However, this distinction was made to differentiate between species that might conquer new habitats under climate change

in Baden-Württemberg in a more natural way, even with a little help (assisted migration, category 2), and species which will be clearly regarded as artificially introduced tree species (category 3).

The species briefing papers are published in German (Albrecht A. & De Avila A.: Alternative Baumarten im Klimawandel: Artensteckbriefe – eine Stoffsammlung. FVA 2018, 122 p.) and can also be found on www.waldwissen.net. The briefing papers were compiled for the following species:

Outlook

The briefing papers of alternative tree species under climate change serve as a first step and help in screening potential candidate species in a systematic way. Based on this first step, extensive species distribution models will be established in the years 2018 and 2019 for a subset of species with very promising profiles concerning future climatic suitability in Baden-Württemberg. Additionally, experimental plantations of the most promising species will be increasingly implemented as field tests to complement existing experiences with alternative tree species.

Atlantic cedar (<i>Cedrus atlantica</i>)	non-native non-European tree species
Black locust (<i>Robinia pseudoacacia</i>)	non-native non-European tree species
Bornmüller's fir (<i>Abies bornmülleriana</i>)	non-native non-European tree species
Common hornbeam (<i>Carpinus betulus</i>)	native tree species
Downy oak (<i>Quercus pubescens</i>)	non-native European tree species
European black pine (<i>Pinus nigra</i>)	non-native European tree species
Grand fir (<i>Abies grandis</i>)	non-native non-European tree species
Hop-hornbeam (<i>Ostrya carpinifolia</i>)	non-native European tree species
Hungarian oak (<i>Quercus frainetto</i>)	non-native European tree species
Japanese larch (<i>Larix kaempferi</i>)	non-native non-European tree species
Lebanon cedar (<i>Cedrus libani</i>)	non-native European tree species
London plane (<i>Platanus x acerifolia</i>)	non-native European tree species
Northern red oak (<i>Quercus rubra</i>)	non-native non-European tree species
Norway maple (<i>Acer platanoides</i>)	native tree species
Ponderosa pine (<i>Pinus ponderosa</i>)	non-native non-European tree species
Silver birch (<i>Betula pendula</i>)	native tree species
Silver lime (<i>Tilia tomentosa</i>)	non-native European tree species
Small-leaved lime (<i>Tilia cordata</i>)	native tree species
Sweet chestnut (<i>Castanea sativa</i>)	native tree species
Turkey oak (<i>Quercus cerris</i>)	non-native European tree species
Turkish fir (<i>Abies nordmanniana</i>)	non-native European tree species
Turkish hazel (<i>Corylus colurna</i>)	non-native European tree species
Wild cherry (<i>Prunus avium</i>)	native tree species
Wild service tree (<i>Sorbus torminalis</i>)	native tree species
Yellow poplar (<i>Liriodendron tulipifera</i>)	non-native non-European tree species

Literature
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INFORMATION FROM REMOTE SENSING DATA FOR FOREST MANAGEMENT

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With the joint project "InFE2" (Information from Remote Sensing data for Forest Management) between the Forest Research Institute of Baden-Württemberg (FVA) and the Department of Forest Management and Forest Geoinformation of the State Forest Service (ForstBW) in Freiburg, a highly interesting, innovative and exciting cooperation between science and praxis started. The aim of this project was developing practical methods of estimating forest stand parameters from remote sensing data for forest management.

Project description

Remote sensing data

Digital aerial stereo photographs include detailed information about forest stands. Stereo photography allows extracting digital surface models (DSMs) by using image matching methods. Additionally, the spectral information of the photographs can be used to classify forest types and tree species. For this research, digital aerial stereo photographs acquired by the State Office for Spatial Information and Land Development Baden-Wuerttemberg (LGL BW) were used. The photographs are regularly acquired in a three-year cycle and are characterized by a forward overlap of 60 % and side overlap of 30 %.

Aerial Stereo Images

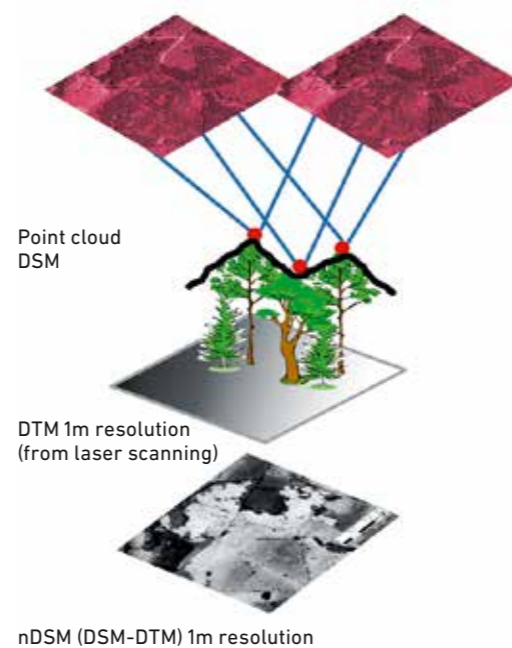


Fig. 1: Processing of remote sensing data

Field data

Sample plots of the forest inventories were used as a reference to model forest variables such as timber volume (m^3/ha) and forest types. These sample plots are arranged in a regular grid of 100 m by 200 m. Each of them is approximately $452 m^2$ in size and consists of four concentric circular subplots with radii of 2, 3, 6 and 12 m, respectively. At each circular plot trees are measured depending on their diameter at breast height (dbh) using thresholds of 7, 10, 15 and 30 cm, respectively. That is trees with a dbh below 7 cm are measured in a plot radius of 2 m, trees with dbh less than 15 cm are measured in a plot radius of 3 m, trees with dbh less than 30 cm are measured in a plot radius of 6 m, and only trees with a dbh larger 30 cm are measured in a plot with 12 m radius.

Method

A standard process was used to extract point clouds from the aerial stereo photographs and to generate raster-DSMs with spatial resolution of 1 m. Normalized digital surface models (nDSM) with 1 m resolution were calculated by subtracting a laser scanning based digital terrain model (DTM) from the photogrammetric DSM (Fig. 1). The nDSMs, their derivatives, and model-based estimations of forest variables were some of the products developed for ForstBW. The suitability of these products is analysed in close cooperation with the forester in the field.

Results

Height structure map (WHSK)

The height of the nDSMs is equivalent to the forest height. The height values of the raster can be aggregated into classes to obtain height structure maps (WHSK). The WHSK is a raster with 5 m x 5 m grid (Fig. 2). It can be used for various purposes in forest management, e.g. to delineate forest stands and to estimate average or dominant stand height or to derive tree heights. The production process of the WHSK was developed and implemented by FVA. In the future, the production of the nDSMs will be carried out by the LGL (division 53 – remote sensing).

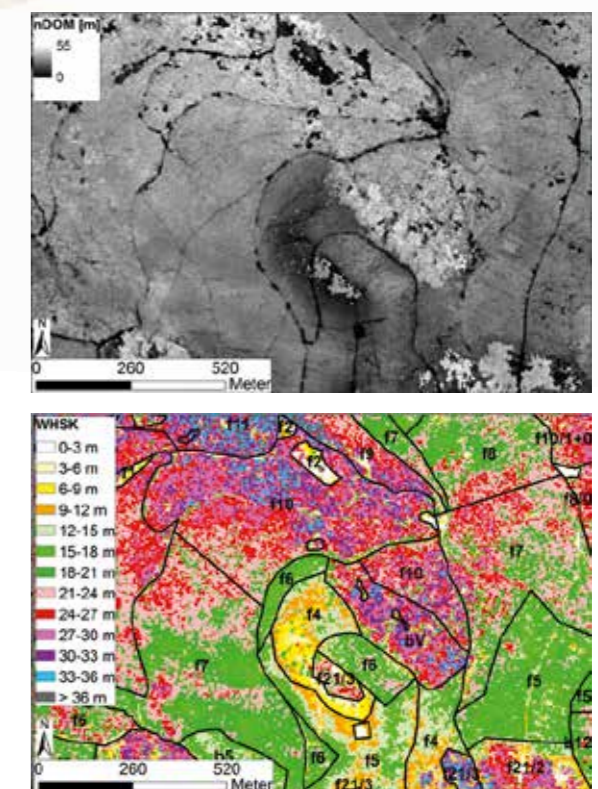


Fig. 2: CHM as reference (top) and height structure map with forest stand borders (bottom)

Homogeneity map

The homogeneity map was developed as a tool to estimate crown closure. This map describes the homogeneity of heights in the forest canopy (regardless of the height of the forest stands).

Map of forest types

An automatic classification of forest types (coniferous and broad-leaf) was developed in a test area using spectral information of aerial stereo photographs (Fig. 3). The mapping of forest types is important for forest management, for planning timber harvesting, and for ecological or conservation issues.

Timber volume map

The timber volume map is a 20 m x 20 m raster product derived from a model-based approach that combines information derived from the sample plots and explanatory variables extracted from digital elevation models (nDSM and DTM). The 20 m x 20 m raster can be aggregated at a forest stand or forest district level (Fig. 4). The timber volume maps are in an evaluation phase and are not yet a final product.

Outlook

Remote sensing data provides new information that can be used for forest tasks that go beyond purely operational forest planning. These tasks include mapping of open forest areas, forest biotope mapping, FFH monitoring, Natura 2000 management planning and wildlife management. Furthermore, mapping of small-scale forest structures and their monitoring over time are of great ecological importance. The availability of digital height structure maps and species composition maps in time series will allow for identifying, documenting, and quantifying any change in the forest canopy.

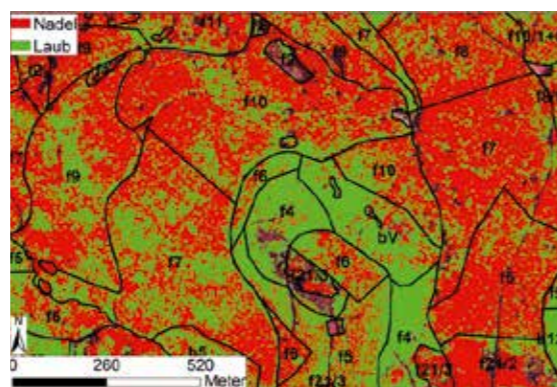
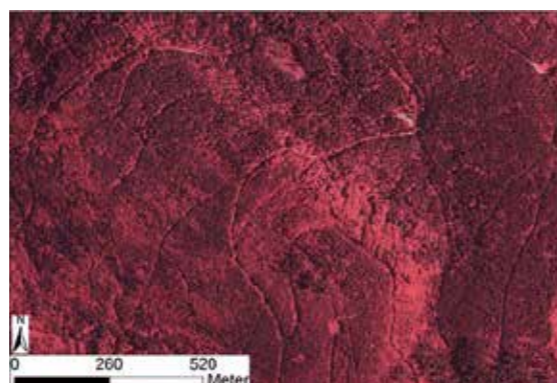


Fig. 3: Digital aerial photograph as reference (top) and forest types with forest stand borders (bottom)

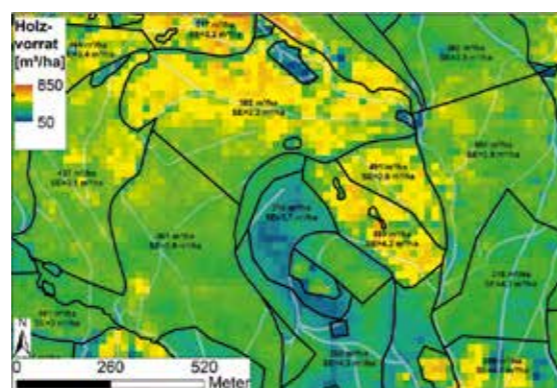


Fig. 4: Timber volume map with mean volume and its standard error by forest stand

ACTIVE REGENERATION OF SOIL DAMAGE

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Since the 1960s, there has been a steady increase in the weight of forestry machinery. Heavy machinery can destroy soil structure, especially when operated under sub-optimal conditions. Natural soil regeneration takes years to decades and the initial state is seldom reached. In this study, plantings of woody subsidiary plants are combined with technical measures to accelerate the restoration of soil functions.

Soil biological and technical measures

In April 2012, a 25-ton forwarder travelled over the soil at the study site (Fig. 1). Three skid trails were created on which the following treatments were applied:

- the addition of lime to improve the formation of aggregates and to reduce soil acidification, promoting biological activity
- a mechanical treatment during which the topsoil is mixed with plant residues (Fig. 2). This introduces organic matter into the soil, which also promotes biological activity (mulch).

The skid trails were then planted with the following tree species: grey alder (*Alnus incana*), red alder (*Alnus glutinosa*), alder buckthorn (*Rhamnus frangula*) and willow (*Salix caprea*). The tree species were selected based on forest cultivation experience and tree physiological characteristics (e.g., adaptation to anaerobic conditions).



Fig. 1: Travelling over the soil with a forwarder

First signs of successful regeneration

Which tree species is suitable?

The survival rates and biometric parameters of the planted trees show significant differences between treatments (Fig. 3). The survival rates of all tree species are higher on the treated skid trails compared to the untreated skid trails and the non-compacted control plots. Alder species had the highest survival rates, followed by willow and alder buckthorn.

How is aeration developing?

In order to quantify soil aeration, gas collectors were installed in the skid trails. At the beginning of the measurements, all trafficked areas showed very high CO₂ concentrations, which is an indication of soil compaction and reduced gas exchange.



Photo J. Schaeffer

Fig. 2: Incorporation of organic material into the topsoil (mulch)

The highest CO₂ values were measured on the mulched skid trail with up to eight percent. This is due to the depletion of organic substances brought in by mulching. In 2015, a sharp decrease of CO₂ concentrations was registered on all skid trails due to extreme drought and the associated formation of shrinkage cracks.

Between 2014 and 2016, aeration improved on most skid trails (Fig. 4). A significant improvement of soil aeration was observed on the planted and treated skid trails. This indicates accelerated regeneration caused by the applied treatments.

How is root growth of alder species developing?

Since 2014, the root growth of alder species has been observed through rhizotron windows (Fig. 5). Root growth is greatest on the non-compacted control plot. In the mulched/planted skid trail, root growth is significantly higher compared to the mulched/unplanted skid trail.

The results of the rhizotron window analyses are supplemented by fine root counts along transects. Most fine roots were found on the non-compacted control plot and the mulched/planted skid trail. The fine root density on the untreated/unplanted skid trail is significantly lower.

Does this result in the restoration of soil structure?

In addition to increasing fine root densities and reduced CO₂ values in the soil, gas diffusion coefficients (D_s/D₀) determined in the laboratory also indicate recovering soil structure. No significant increase in gas diffusion coefficients were observed on the untreated/unplanted skid trail. The mulched/limed/planted skid trail showed a significant increase in gas diffusion coefficients. High values indicate an enhancement of pore structure.

Which treatment is most suitable?

Both alder species (*Alnus incana* and *Alnus glutinosa*) show high survival rates and solid growth. This provides evidence for their suitability for planting them on compacted soils. In combination with mulching or the application of lime, aeration, root penetration and soil structure were improved. The results to date are promising in terms of enhancing compacted soil through specific measures. However, the positive effects are currently limited to the topsoil. Further investigations are necessary to identify long term effects.

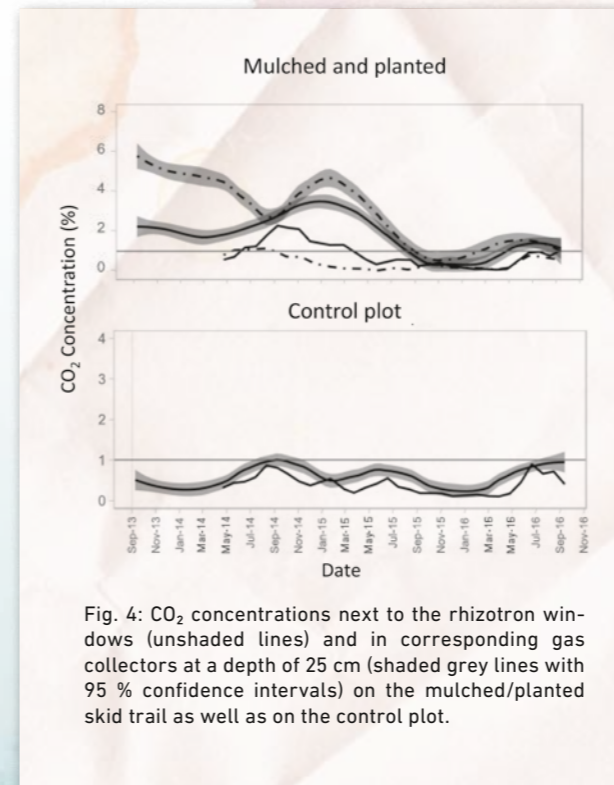


Fig. 4: CO₂ concentrations next to the rhizotron windows (unshaded lines) and in corresponding gas collectors at a depth of 25 cm (shaded grey lines with 95% confidence intervals) on the mulched/planted skid trail as well as on the control plot.

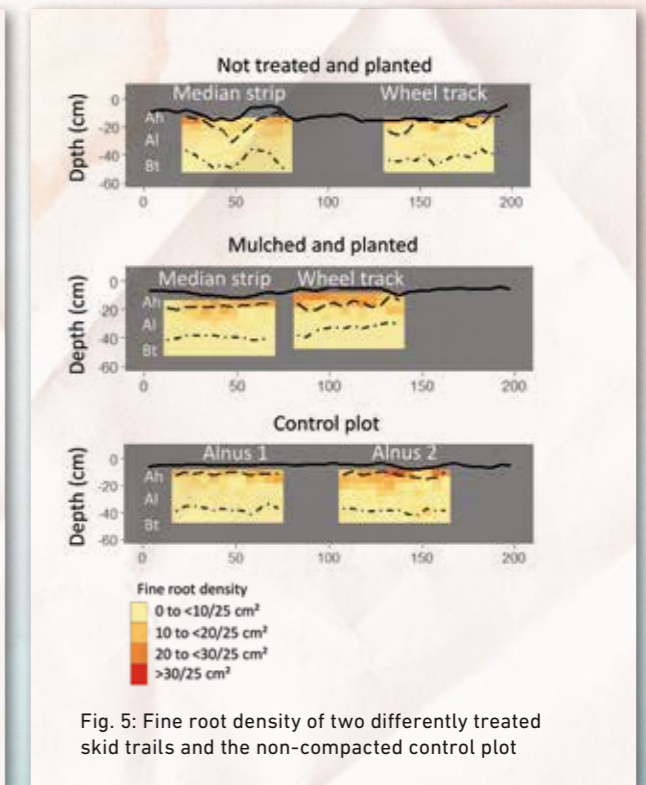


Fig. 5: Fine root density of two differently treated skid trails and the non-compacted control plot

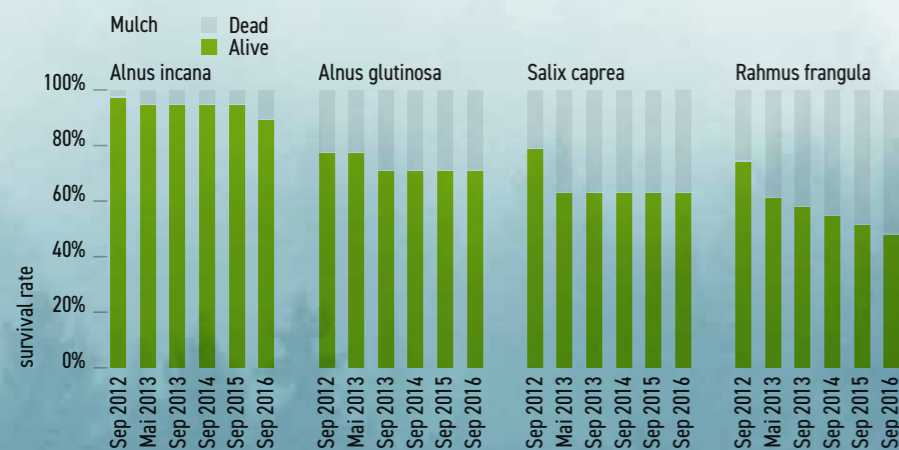


Fig. 3: Survival rates (in %) of the different tree species on the mulched skid trail between September 2012 and September 2016

RECREATIONAL ACTIVITIES IN WILDLIFE HABITATS: RESEARCH RESULTS FOR PRACTITIONERS

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Combining the requirements of forests as habitat for wildlife with increasing human recreational pressure in forests has increasingly become a challenge. Ever more forested areas are regularly used for a variety of human recreational activities, which are often perceived as hazardous to wildlife. Undisturbed wildlife refuges are steadily declining, which can in turn affect a variety of management goals including hunting, forestry and tourism. Therefore, the department of wildlife ecology has been concerned for many years in various projects that ask the question:

How can we manage the diverse human demands on forests without restricting the needs of wildlife?

The results of scientific research provide a solid basis for developing and implementing management schemes and tools. These should include both human demands and needs from forests as well as providing refuges for wildlife. The research and knowledge transfer project "anthropogenic activities in wildlife habitats" links together several projects within the department and their accompanying development and implementation of practical measures.

Scientific research...

We studied the effects of recreational infrastructure on wildlife in the Black Forest by tagging red deer and capercaillie (grouse). We found that red deer avoid recreational infrastructures (i.e. hiking trails, mountain bike trails in

summer, cross-country skiing and groomed ski trails in winter) during the day (Coppes et al. 2017a). During the night, when no humans were present, they preferred areas close to trails. At the same time, deer preferred the wildlife refuges of the management zonation scheme (Suchant et al. 2008). Capercaillie also avoided recreational infrastructures (Coppes et al. 2017b). During summer we found an avoidance of recreational infrastructure of up to 145 meters. During winter however, with less vegetation providing cover, the avoidance distance of winter hiking trails, cross-country-skiing trails and downhill tracks was up to 320 meters. This distance, however, was reduced with the presence of a dense shrub layer (Coppes et al. 2017b).

...as a solid base for management

To ensure that these and other results are transferred into practice, these scientific results were also prepared and published in local, target group specific journals. Thus, a common knowledge base was created on which management options and schemes can be discussed and worked out. Furthermore, a brochure was compiled in cooperation with the German Sport University Cologne. This brochure



provides information to the public about wildlife-friendly behavior in forests (Kopp et al. 2017).

As part of a biennial expert meeting organized by the department, the "Denzlinger Wildtierforum", more than 300 participants from the fields of tourism, sport, hunting and forest discussed the requirements of different groups and possible solutions to satisfy their various needs.

The department of wildlife ecology also supervises the initiative "Respect Wildlife", of the Ministry of Rural Affairs and Consumer Protection, as well as providing background knowledge to the initiative. Representatives of the hunting community, nature and animal protection as well as of recreation and tourism cooperate in developing wildlife-friendly concepts for nature recreation.

In addition to the communication and committee work, another focus is on the development and implementation of the instruments provided for in the hunting and wildlife management legislation (JWVG) to reduce the effects of human disturbance on wildlife.

Outlook: what's next?

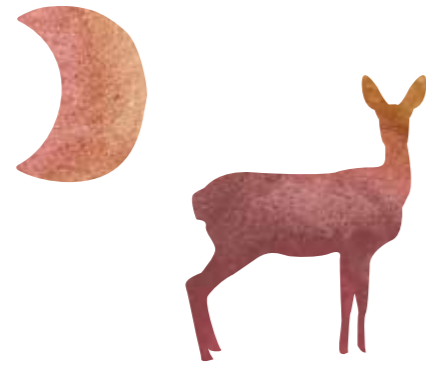
In the coming years, the capercaillie action plan and the local red deer management plans will be evaluated. The results should give insight into the effectiveness of and the possibility of optimizing the management of reducing human disturbance to wildlife. At the same time, a new red deer

management plan will be developed for the Northern Black Forest. This plan, among other things, aims to designate spatially explicit wildlife refuges. These refuges will be developed using a joint participatory process within regional working groups. The aim is also to develop wildlife ecological criteria for revising and redesigning wildlife refuges, to coordinate working groups, to test them in practice and to develop guidelines for future designation of wildlife refuges.

Clearly the topic of how anthropogenic activities affect wildlife will continue to engage all the players involved with forest management over the next few years. The FVA will continue to play a key role in providing the scientific basis for decision making and managing the forest and wildlife. With this background, management concepts can be developed and tools can be implemented to aid in creating hunting legislation that in the future will reduce human disturbance to wildlife.

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DO WILDLIFE WARNING REFLECTORS INFLUENCE THE BEHAVIOR OF ROE DEER?

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Every year, 260,000 wild animals are killed in road accidents. Eighty-five percent of those animals are roe deer. In Germany, one accident involving wildlife happens every two minutes. However, the number of cases is assumed to be much higher because many accidents are not reported. Nationwide, reported wildlife-road accidents cause damage amounting to more than 650 million euros, which are covered by German insurance companies.

Wildlife warning reflectors are the most commonly used prevention measures against road kill. Over the last several decades, a multitude of reflectors have become available that, according to manufacturers, reduce road accidents with wildlife. Blue wildlife warning reflectors are meant to prevent accidents especially due to their color. The evaluation of the effectiveness of wildlife warning reflectors has been assessed nearly entirely by the change in numbers of road kills. Studies that analyze behavioral reactions of wild animals have not been done in Germany. The question of whether installing wildlife warning reflectors influence the behavior of wild animals in the proximity of streets or when crossing roads was studied in a five-year research project of the Forest Research Institute Baden-Württemberg (FVA).

The project focused on the following questions:

1. Is the color blue effective as a warning color as claimed by manufacturers?
2. Does the light stimulus of the blue semicircle reflectors minimize behavior of wildlife that leads to accidents?

The color blue – a warning color?

As part of a cooperative project with the Leibniz Institute for Zoo and Wildlife Research (IZW) in Berlin, blue and warm white lights were analyzed to determine whether they influence behavior of roe deer and if the color blue actually is a "warning color". The investigation was designed as an experimental feeding study in which the behavior of 15 captive deer was observed. For this purpose, feed bowls were illuminated



Structurally modified feeding station with three feed bowls. In this arrangement, the left feed bowl is unlit, the bowl in the middle is illuminated with blue light and the right bowl lit with warm white light.

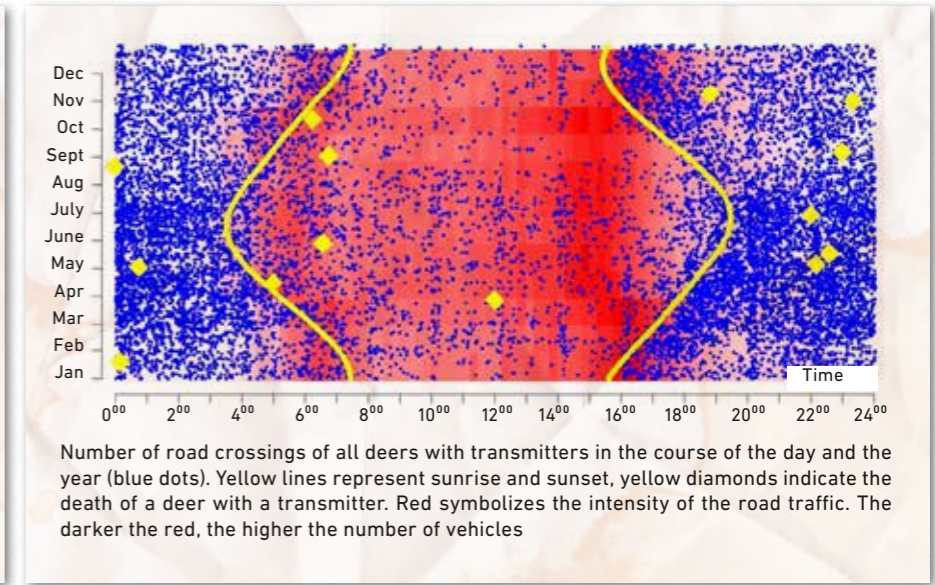
in a randomly chosen order with blue and warm white light, and one feed bowl served as control and remained always unlit. The animals were able to freely choose between the feed bowls. Their behavior was monitored with infrared cameras. The statistical results showed that the animals chose the blue-lit bowl 37% of the time followed by the white-lit bowl (34%). The unlit bowl was chosen 29% of the time. When the length of the feeding period was considered, it became clear that the animals fed on the blue and white-lit bowl on average about 10 seconds shorter than on the unlit feed bowl. These results indicate that light had a significant impact on the animals, but the manufacturers' claim that the blue color is a "warning color" could not be confirmed.

Reflector affects roe deer behavior?

The question of whether roe deer change their behavior in the presence of blue semicircle reflectors was investigated in road traffic situations at five street sections in Baden-Württemberg and under controlled conditions (enclosure) in cooperation with IZW.



Wildlife warning reflector, type "Blue Semicircle Reflector"



Number of road crossings of all deer with transmitters in the course of the day and the year (blue dots). Yellow lines represent sunrise and sunset, yellow diamonds indicate the death of a deer with a transmitter. Red symbolizes the intensity of the road traffic. The darker the red, the higher the number of vehicles

To analyze the behavior at the different street sections, thermal heat cameras were used that recorded 16,000 hours of video, which showed there was 1,062 times that a situation involved roe deer and vehicles. It turned out that the proximity of the roe deer to the street is decisive for how strongly the animal reacted to approaching vehicles. Animals next to the road reacted most commonly through vigilance or flight behavior. The further they were from the street the less common was this kind of reaction. Moreover, recorded video showed that the kind of behavior depends on the type of approaching vehicle and that the animals react more strongly to buses and trucks. The blue semicircle reflectors did not change the behavior of the animals in a way such that flight and vigilance behavior was increased when there were approaching vehicles. The reflectors had no effect on the behavior of the animals. The reactions of roe deer to blue semicircle reflectors were also tested in an enclosure under controlled conditions on 33 animals. Both male and female animals showed the same unaltered behavior as the roe deer studied at the road sections. Thus, the results of the field experiment were confirmed.

Individual differences in road crossing behavior

In addition, the behavior of 46 deer was observed and documented over several years with the aid of GPS telemetry transmitters. The investigation centered on whether spatial or temporal changes in road crossing behavior occurred after installing blue semicircle reflectors. Thirty-two deer eventually crossed roads and they made 13,689 crossings, which were analyzed. It turned out that the animals had large individual differences in behavior. The frequency of road crossings was determined by the recorded movement activity of the individual animal: active animals crossed the road more

often than inactive animals. Additionally, the activity of the animals was subject to diurnal as well as seasonal fluctuations. At twilight and at night, as well as in spring and autumn, animals were more active. Also, in this investigation, the blue semicircle reflectors did not influence the behavior of the roe deer. There was no change in frequency of road crossings in the different observed areas or where there were shifts of attempts of crossings from twilight and night to daytime hours. Also, the number of approaching vehicles had no effect on crossing behavior.

Conclusion

Determining the effectiveness of wildlife warning reflectors based on changed wildlife accident numbers is critical because of many influencing factors. The deterring effect of the reflectors cannot be clearly shown. An analysis of 43 studies regarding wildlife warning reflectors published in the last 40-years showed that reflectors did not significantly reduce wildlife casualties. However, a definitive statement allows for only the analysis of the behavior of wild animals. Looking directly at the roe deer behavior, it becomes clear that blue semicircle reflectors do not cause changes neither regarding behavioral alteration of deer at the roadside in the presence of traffic nor in the long term concerning the frequency of road crossings in GPS-collared roe deer. In enclosures under controlled conditions roe deer exhibited the same behavioural patterns compared to deer close to roads. These results confirmed those of the field experiment. In addition, feeding experiments did show that blue is not a "warning color" for deer. In summary, this extensive behavioral study demonstrates that wildlife warning reflectors are not a suitable preventive measure for reducing vehicle-wildlife accidents.

SPREADING DYNAMICS OF THE EUROPEAN SPRUCE BARK BEETLE IN THE BLACK FOREST NATIONAL PARK

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The Knowledge Dialogue Northern Black Forest is one of seven real-world laboratories of the state of Baden-Württemberg. These projects were funded from January 2015 until December 2017 by the Ministry of Science, Research and the Arts in the state of Baden-Württemberg. Real-world laboratories are a new form of research with a focus on the collaboration between science and civil society. The aim of this approach is to achieve a better integration of scientific findings into politics, economy and society. The research topics of the Knowledge Dialogue Northern Black Forest were developed with the local population in a kick-off event. The main subject of the real-world laboratories is the sustainable development of the region. The topic “bark beetles” was requested by the local population due to its topicality in the context of the founding of the national park.

Targeting: the habitat preferences of European spruce bark beetle

The European spruce bark beetle (*Ips typographus* L.) is one of the major forest pests of central Europe’s commercial forests. Because of its high forest economic relevance much research has focused on *Ips typographus*. The main focuses of research are the dispersion and the host detection of the European spruce bark beetle. A risk assessment of forest stands is possible knowing factors that influence the spread of this bark beetle. This allows for a temporally and spatially precise and effective management of this pest; a so called “Precise Pest Management” that saves resources and protects habitats from avoidable interventions and disturbances.

The goal of the research is to identify the locations that are preferred by *Ips typographus* and thus would be particularly at risk for infestation. To achieve this, the specific characteristics of landing sites of the European spruce bark beetle are analyzed to determine the stand and terrain structures that are preferred during dispersion.



Marked European spruce bark beetle on the bark of a breeding tree

Photo: J. Hinze

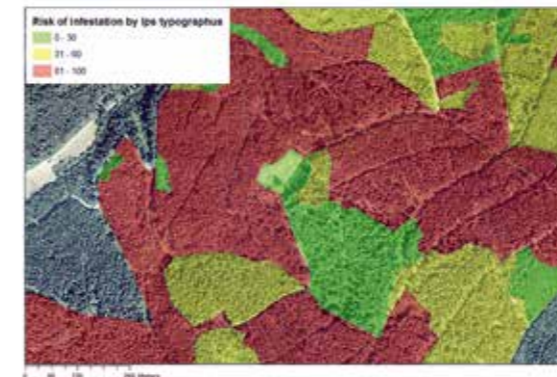
The method

Beginning in 2015 and continuing until 2017 breeding trees for *Ips typographus* in form of spruce trunks were laid out in a study area in the Black Forest National Park. Colonization was stimulated by using an attractant. The bark surface was covered with a fluorescent color before the beetles emerged from the bark. While boring out the beetles marked themselves passively with pigments of the color. Thereupon it was possible to identify the marked beetles in approximately 60 pheromone traps, which were widely distributed within the study area to catch the bark beetles. Data from every corresponding pheromone trap was collected to identify spatial and structural preferences of *Ips typographus*. Using data from the daily trap catches it was possible to draw conclusions about the spreading dynamics, the flight distances and the special preferences of the dispersing bark beetles. Subsequent analysis showed the age (young or old) and the sex of every single beetle caught and this allowed us to discover differences in spreading behavior.

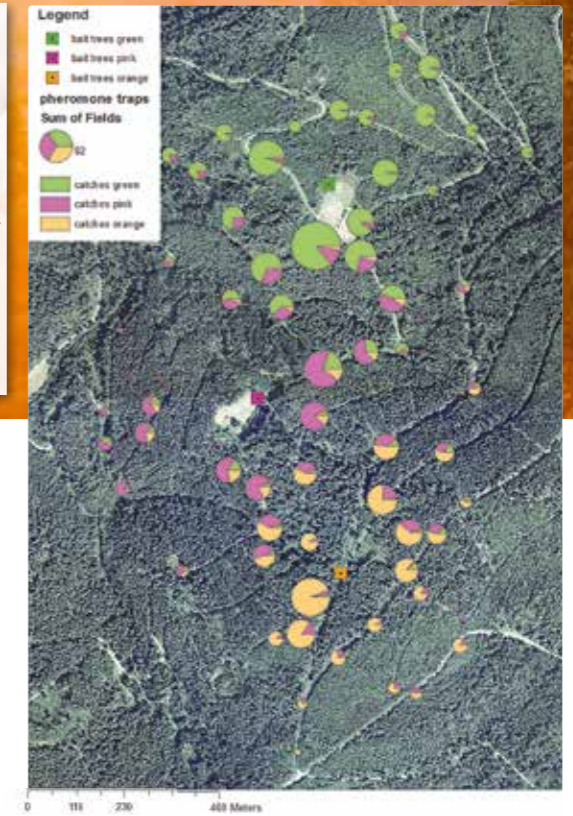


Coloring breeding logs in the Black Forest National Park

Photo: J. Hinze



Example of a risk map to visualize the various exposures of stand structures to bark beetle infestation



Total catches of the individual pheromone traps in 2016

Results

In 2015, more than 6,000 marked individuals of *Ips typographus* were caught in the pheromone traps. Data obtained from these beetles showed that neither age nor sex have a significant influence on the spreading behavior of the bark beetle. Subsequently the experimental design was optimized in 2016 to focus on the structural preferences of *Ips typographus* during dispersal. The number of catches of marked beetles in the different traps varied widely during the trial period in 2016. Statistical analyses of the influence of more than 30 spatial parameters on recapture ratio revealed five parameters that are suitable for a good prediction of favored locations of the European spruce bark beetle: (1) the proximity to an infestation of *Ips typographus* has a positive effect on the catches of the bark beetles, (2) the “Topographic Wetness Index” (TWI) is a steady state wetness index calculated from a digital terrain model. Using the TWI showed that *Ips typographus* preferred dry locations, (3) a small number of broadleaved trees in the surrounding of a bark beetle trap lowered the number of catches significantly, (4) a high timber volume of Norway spruce in the vicinity of a trap had an attracting effect on the beetles and (5) a high crown proportion measured at a height of 20 m was attractive as well. In 2017, the experiment was

repeated to validate the preliminary results of 2016. However, only a few marked beetles were caught because of the high attracting effect of an infested forest stand near the traps and unfavorable weather conditions. Despite this situation catches of the wild population of *Ips typographus* enabled us to validate the computed models of 2016 and we were able to identify the structural preferences of the bark beetles.

Benefit for the Northern Black Forest region

The protection of forests bordering the Black Forest National Park has highest priority in the Northern Black Forest. Using knowledge of the accurate habitat preferences and dispersion dynamics of the European spruce bark beetle it is possible to create risk maps for forest stands, which can lead to sophisticated recommendations for targeted and efficient infestation controls. These risk maps can specify pest management strategies for *Ips typographus* in the commercial forests as well as in the buffer zone of the Black Forest National Park. This allows us to protect forests adjacent to the national park and helps preserve the typical landscape of the Northern Black Forest throughout the area.

IMPLEMENTATION OF NATURA 2000 IN FORESTS OF BADEN-WÜRTTEMBERG

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Baden-Württemberg's Natura 2000 implementation strategy is one positive example within a European context and in comparison with the other German states. The state of Baden-Württemberg completed the nomination of its Natura 2000 sites in 2008. Detailed management plans should be available for all its 302 sites by 2020. About 60% of these sites are forested.

According to the 3rd Federal Forest Inventory (year of reference 2012), management of public forests in Baden-Württemberg follows the established general concept of 'close-to-nature' forest management ('Naturnahe Waldwirtschaft'). A variety of integrative management concepts are being implemented to provide ecosystem services, timber production, nature and biodiversity conservation, as well as recreation opportunities within the same forest areas. The aim is to provide multifunctional and sustainable forests to society and reach the Natura 2000 conservation targets at the same time.

The EU's Flora-Fauna-Habitats Directive (FFH) addresses different specific forest habitats and species (Waldlebensraumtypen (WLRT) und -arten). In Baden-Württemberg beech and oak forest stands, and acidophilous montane spruce forests are considered very significant. Most sensitive are the bog woodlands and sarmatic steppe pine forests. The most important forest animal species addressed are bats, woodpeckers, hole-nesting and aerie-breeding birds, as well as xylobiotic beetles. Some of the species listed are endangered and occur only locally.

Strategy

Natura 2000 conservation objectives are to be fully included into regular forest management procedures. Therefore, their

implementation in forests follows an integrative approach. By developing well-grounded Natura 2000 management plans in concordance with all other forest management activities, all conservation objectives are expected to be reached while inconveniencing forest enterprises as little as possible. This approach depends heavily upon the individual responsibility of the forest owners and is based on the political will to keep regulatory measures to a minimum.

Conceptual implementation

Natura 2000 management plans describe and appraise locally relevant species and habitats. Necessary conservation measures are developed and depicted within a „4 pillar concept“.

Pillar 1:

Management of Flora Fauna Habitat (FFH) forest habitats

Management of Natura 2000 habitats in Baden-Württemberg's public forests follows the state's silvicultural guidelines "WET-RL" (Waldentwicklungstyp-Richtlinie). The required measures consequently maintain (i.) the size of a specific forest biotope, (ii.) the amount of deadwood and habitat trees, and (iii.) the conservation status of the forest habitat.

Pillar 2: Care for special habitats

'Special habitat' types, not listed in the FFH forest habitats, such as alluvial forests, are legally protected forest biotopes. All conservation and utilization measures in these biotopes also must follow the WET-RL guidelines.

Pillar 3: Management of species' habitats

Many forest species depend on deadwood and (old) habitat trees with specific micro structures. A state specific 'Old Trees and Deadwood Concept' (Alt- und Totholz-Konzept AuT) strives for permanent regional interconnectivity of these

structural habitats in managed forests. Condensed and practice-oriented management guidelines for forest enterprises are available on all relevant species listing suitable conservation measures, as well as supportive or detrimental forest management measures.

Pillar 4: Care for specific species

Special care strategies are applied for all Natura 2000 species which occur in forests but do not depend on specific tree structures. Localized conservation measures are defined by experts in consultation and agreement with forest enterprises

Economic dimensions

Forest enterprises fulfilling Natura 2000 conservation objectives are experiencing additional management expenditures and reduced income.

Based on first exemplary management plans and averaged non-utilization obligations, a scientific forecast study projects timber production in Natura 2000 forests to be reduced by 0.4 m³/ha/yr to an average of 6.1 m³/ha/yr. In addition, growth increment, timber quality, and tree species composition will change. Timber production value in Natura 2000 forests in Baden-Wuerttemberg would consequently be reduced by about 30% to 117€/ha/yr, equivalent to about -50€/ha/yr. For the state of Baden-Württemberg these figures would result in a difference of over -11 million EURO per year or -3.9% of all revenues from forestry.

The economic consequences of implementing Natura 2000 are moderate for the forest sector in Baden-Württemberg and do not threaten the economic sustainability of forest management. None the less, the resulting opportunity costs reduce the economic achievement potential of the forest-based sector. In some Natura 2000 sites, however, the reduction of timber production values may reach a magnitude where individual forest enterprises are seriously affected, especially where the conservation area and

measures affect a better part of the enterprise's forests. Practical support and financial compensation measures are thus essential. In state forests additional expenditures and reduced income are borne by the state forest enterprise. Whether or not municipalities obliged to implement Natura 2000 will be reimbursed by the state is not yet resolved. Private forest owners implementing Natura 2000 by choice are already being offered a financial compensation lump sum of 50 € per hectare per year.

Challenges

The bio-geographic and forest political starting conditions in Baden-Wuerttemberg are generally favorable for an effective implementation of Natura 2000 in forests. The integrative approach presented here is suitable to reach high acceptance by landowners, to minimize conflicts, and to reach the conservation goals. However, the participatory approach depends heavily on the good will of the stakeholders. A more comprehensive mobilization of promoters is desirable to reach better participation and higher effectiveness. More appropriate financial incentives for selected target groups, especially private forest owners, need to be developed as they are considered indispensable to enhance their engagement. Furthermore, the negative economic consequences could be reduced substantially if economic considerations were incorporated in the designation of Natura 2000 areas and the planning of conservation measures.

An increase in resources in terms of better communication, staff, money, and time, would further foster the successful implementation of Natura 2000 in forests of Baden-Württemberg – possibly also in other German states and other EU Member States.

Full publication: Schabel, A.; Schmack, S.; Grossmann, C.: Case Study: Natura 2000 implementation in forests in Baden-Württemberg, Germany. In Sotirov, M. (ed.) (2017): Natura 2000 and Forests – Assessing the State of Implementation and Effectiveness. EFi What Science Can Tell Us 7, 72-77



Tending measures are at the core of FFH conservation management, such as this one discussed in the Hotzenwald.

Photo: A. Schabel

ORGANIZATION of the FVA

ADVISORY BOARD

DIRECTORATE | DIRECTOR

- Prof. Konstantin von Teuffel*
- Administration and Management
 - Central Technical Services und Library
 - Knowledge Transfer and Public Relations
 - Controlling



Dept. 1 FOREST GROWTH

PROF. DR. ULRICH KOHNLE

- Network of Longterm Experiments
- Growth and Environment
- (incl. Coordination of FVA-Research on Climate Change)
- Growth Simulation

Dept. 2 FOREST NATURE CONSERVATION

DR. JÖRG KLEINSCHMIT

- Forest Plant Ecology
- Forest Biotops
- Forest Nature Reserves
- NATURA 2000
- Forest Tree Breeding¹
- Forest Plant Genetics

¹in Cooperation with ASP Teisendorf

Dept. 3 SOIL AND ENVIRONMENT

DR. HEIKE PUHLMANN

- Environmental Monitoring
- Soil Physics
- Forest and Water
- Forest Nutrition and Element Budgets

Dept. 4 FOREST HEALTH

DR. HORST DELB

- Forest Entomology, Zoology and Forest Pathology
- Monitoring, Prognosis and Control of Forest Pests and Diseases
- Forest Health Advisory Service

Dept. 5 FOREST AND SOCIETY

PROF. DR. ULRICH SCHRAML

- Social Cultural Forest Monitoring
- Recreation & Human Health
- Forest Politic Tools
- Wildlife Management

Dept. 6 FOREST UTILISATION

DR. UDO HANS SAUTER

- Harvesting and Logistics
- Wood Measurement, Scaling and Grading
- Applied Wood Research
- Energy Wood

Dept. 7 FOREST ECONOMICS

DR. CHRISTOPH HARTEBRODT

- Accountancy Networks
- Forest Managerial Economics
- Risk and Crisis Management

Dept. 8 BIOMETRY AND COMPUTER SCIENCE

DR. GERALD KÄNDLER

- Forest Inventory and Management Planning
- Modelling
- Climate Change Research and Integrated Risk Management
- Statistics and GIS Consulting; Geodata Management
- Software Engineering
- Information- and GIS Technology

FACTS AND FIGURES

As a departmental research institute for forestry, the Forest Research Institute of Baden-Württemberg (FVA) is associated with the Baden-Württemberg Ministry for Rural Affairs and Consumer Protection (MLR) and is very closely linked in terms of organisation with the State Forest Service ForstBW. In accordance with the task defined in the State Forest Act (§76 LWaldG), the FVA investigates the relationships between the forest and the environment and develops efficient, rational ways for forestry and the timber industry to protect the commercial as well as the ecological and recreational functions of forest. The FVA strategy for 2014 - 2018 sets out the following research priorities: 1) climate change research, 2) forest nature conservation, and 3) measurement and evaluation of sustainability.

The FVA comprises eight specialist departments according to the scope of tasks that are required; these departments are coordinated and managed by the Directorate (see organization chart). An Advisory Board advises FVA on matters related to content and strategic issues. The Advisory Board's tasks and responsibilities include evaluating the overall development and direction of the FVA and formulating recommendations for strategic alignment, priorities for future research work and specific research projects. The Advisory Board also evaluates individual projects before they start with respect to their practical relevance and scientific approach.

The Advisory Board consists of the following eight members, who represent research and practice in forestry:

- **Prof. Dr. Jürgen Bauhus**
Albert-Ludwigs-University Freiburg
- **Dr. James Kirchner**
Swiss Federal Institute of Technology, Zürich
- **Prof. Dr. Daniela Kleinschmit**
Albert-Ludwigs-Universität Freiburg
- **Prof. Dr. Barbara Koch**
Albert-Ludwigs-University Freiburg
- **Prof. Dr. Friederike Lang**
Albert-Ludwigs-University Freiburg
- **Dr. Peter Mayer** (Chairman of the Advisory Board)
Austrian Research Centre for Forests, Vienna
- **Prof. Dr. Bernhard Möhring**
Georg-August-University Göttingen
- **Felix Reining**
State Forest Service ForstBW

The following persons also attend the biannual Advisory Board meetings: State Forestry President Max Reger, Chief Executive Officer of ForstBW and Head of the Forestry Department in the Ministry for Rural Affairs and Consumer Protection (MLR); Bernhard Panknin, Head of Unit, responsible for forest research, MLR; Prof. Konstantin von Teuffel, Director of the FVA; and Kristin Vollmar, Secretary of the Advisory Board. During the autumn meeting, Jürgen Bauhus, James Kirchner and Bernhard Möhring took their leave of the Advisory Board after being members for two sessions (eight years altogether). In 2018, three new members will be announced.



Extended Advisory Board (from left):
Bernhard Möhring, Felix Reining, Daniela Kleinschmit, Sibylle Werner,
Friederike Lang, James Kirchner, Peter Mayer, Jürgen Bauhus,
Barbara Koch, Kristin Vollmar and Konstantin v. Teuffel

FVA as part of the network 'Family as Success Factor'

After the FVA received the 'Family-friendly Enterprise 2016' award, the organisation is now additionally a member of the network 'Family as Success Factor' since the beginning of 2017. As a member, the FVA wants to visibly show its intensive efforts on reconciling professional work and family life. This network is a central platform for German enterprises interested or already involved in the promotion of family-friendly human resources policy. The network is a joint initiative of the German Federal Ministry of Family Affairs, Senior Citizens, Women and Youth, and the Association of German Chambers of Commerce and Industry. It is supported by the European Union within the federal programme of the ESF called "Shaping the balance between professional career and family life".

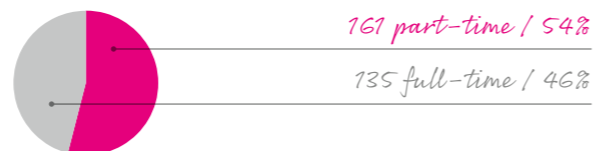
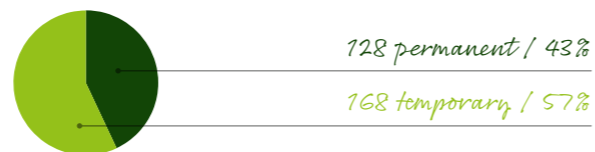
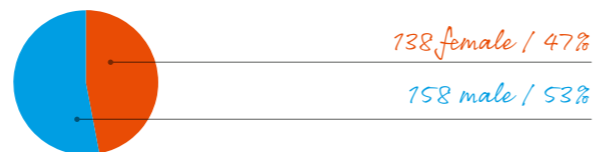
Employee numbers have increased greatly

At the end of 2017, 296 persons were employed by the FVA – 47 percent female and 53 percent male. Compared to the previous year, the number of employees increased by 37 persons the gender ratio remaining the same. Forty-six percent of all employees worked full-time while 54 percent were part-time. This shows a decline of two percent in full-time employment during the year. The proportion of women in the total number of part-time employees was 54 percent. Forty-three percent of all employees had a permanent employment contract at the end of 2017, of which 59 percent were male and 41 percent female. Furthermore, employees included 127 scientific workers (43 percent), 78 scientific assistants (26 percent) and 91 non-scientific personnel (31 percent). Six percent of employees had other than a German nationality. They came from the following countries: Australia, Brazil, Bulgaria, China, Colombia, Finland, Greece, Italy, Latvia, the Netherlands, Poland, Romania, Spain, Switzerland and Venezuela.



Total number of employees (31.12.2017):

296



News from the Sustainability Council

The 17 th Annual Conference of the German Council for Sustainable Development took place at the end of May in Berlin. Since November 2016, Professor Dr. Ulrich Schraml, Head of the Forest and Society Department has been a member of this council. In particular, the Chancellor's visit, with its mixed interim assessment of the Federal Government's sustainability policy, brought the event to the public's attention. She pointed out that the need for action in most of the policy areas is great, if Germany aims to align itself with international sustainability goals of the United Nations. In addition, Ulrich Schraml and the former mayor of Stuttgart, Wolfgang Schuster, were the hosts of a panel concerning sustainable urban development. During this event, the importance of forest areas close to the city and the potential of timber work and experiences with public participation were discussed. Great interest was shown for the currently planned research of the FVA concerning ecosystem services of urban forests.

A further honorary post for Ulrich Schraml



Uli Schraml

Photo: D. Auerschiegler

In September, the Federal Ministry of Food and Agriculture launched a nationwide platform 'forest sports, recreation, health'. During the inaugural session of this platform, Prof. Dr. Ulrich Schraml was elected as chairman. The list of participants include the Consortium of German Forest Owners Associations (AGDW); the German Sport University Cologne; the German Forestry Association; the German Forestry Council; the German Hunters' Federation; the German League for Nature and Environment; the German Olympic Sports Confederation; the German Association of Towns and Municipalities; the German Tourism Association; the Forest Research Institute Baden-Württemberg; the Hessian Ministry of Environment, Climate Protection, Agriculture and Consumer Protection as representative of the federal states; the Advisory Board Sports and Nature; the German Forest Protection Association, as well as the Association of German Nature Parks.

The platform aims at improving the conditions for sports and recreation in the forest. Therefore trade-offs between recreation seekers and sporting enthusiasts on the one hand and foresters, nature conservationists and hunters on the other hand should be reconciled. Moreover, the platform has the goal of educating and informing people to improve the balance of interests, to determine the need for research and to identify new challenges.

Angela de Avila awarded



Angela de Avila

In December Dr. Angela Luciana de Avila, a researcher at the Department of Forest Growth at the FVA, received the Thurn and Taxis Award 2017 at the residence of its founder in Regensburg. This award was instituted in 1978 and is given to young forest scientists who excel in their achievements during and after their studies. De Avila received this award for her research on the recovery of a tropical rain forest following silvicultural interventions in the Brazilian Amazon region. De Avila, a native Brazilian, studied Forest Sciences in Brazil and completed her PhD at the Faculty of Environment and Natural Resources of University of Freiburg. She has been employed at the FVA since the beginning of 2017.

Visitors



Ministerial Director Grit Puchan

Photo: T. Waidner

At the beginning of 2017, Friedlinde Gurr-Hirsch, State Secretary of the Ministry for Rural Affairs and Consumer Protection (MLR) visited the FVA – accompanied by Reinhold Pix, a local politician of the Green Party in the Federal Parliament. Both politicians had visited the FVA a couple of times earlier, whereas Grit Puchan, the Ministerial Director of MLR visited the FVA shortly before the Easter for the first time. She was very eager to get information about the research activities, main research topics, organisation and employee structure, as well as, finances of the FVA. She intently listened, asked many questions and discussed issues with scientists. For instance, she wanted to know everything about the quarantine organisms in the forests and their actual situation. She, as well as Ms Gurr-Hirsch during her visit, greatly appreciated visiting the FVA Day Care Center. Both of them were particularly impressed about its nature and sustainability-oriented concept.

Other political visitors included Wilfried Klenk and Marion Gentges, both Members of the Federal Parliament and Members of the CDU-Party. Moreover, forest trainees from other Federal States (Lower Saxony and North Rhine-Westphalia), Members of the Association of German Engineers, forest students from the Ukraine as well as other foresters from Hungary, Vietnam, Honduras and South Korea became acquainted with the FVA during their visits.



Recent doctorates

The two following FVA scientists completed their doctoral thesis in 2017:

Falko Brieger (Forest and Society Department) on the topic "Assessing the effectiveness of wildlife warning reflectors to mitigate animal-vehicle collision"

Stefan Stängle (Forest Utilisation Department) on the topic "Bark Thickness of Norway Spruce (*Picea abies* (L.) Karst) and Silver Fir (*Abies alba* Mill.) in Southwest Germany"

Big Birthdays

Dr. Gerald Kändler, Head of the Biometry and Computer Science Department celebrated his 60. Birthday on January 3.

Dr. Hansjochen Schröter, former Head of the Forest Health Department turned 70 on June 3.

Prof. Dr. Helmut Brandl, former Head of the Forest Economy Department turned 80 on September 28.

The FVA congratulates them on their milestone birthdays.

More EU funding

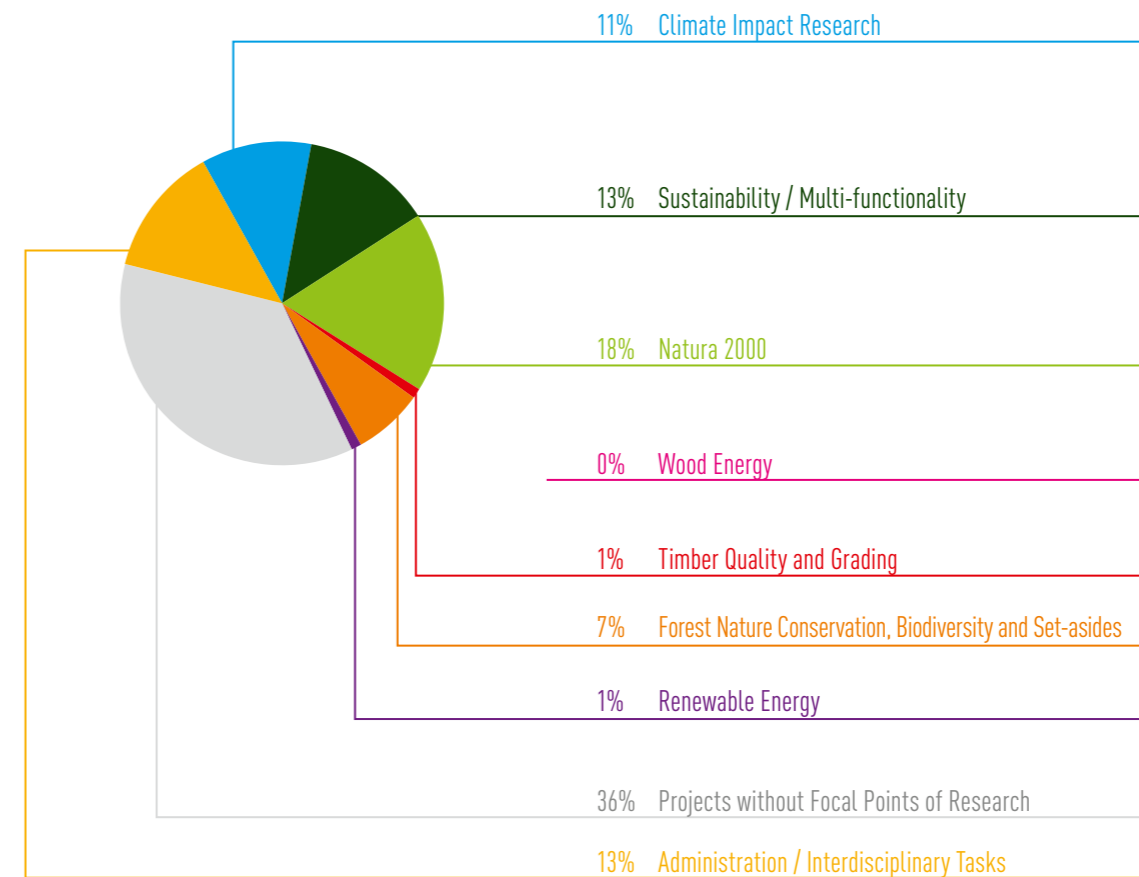
In 2017, the total FVA budget amounted to approximately 15.2 million euros. Eighty-seven percent of this amount was allocated to the research budget and 13 percent to administration and cross-sector tasks. With almost 2.8 million euros, the proportion of third-party funds made up 18 percent of the total budget, which is slightly more than the year before (14 percent of the total budget). Compared to the previous year,



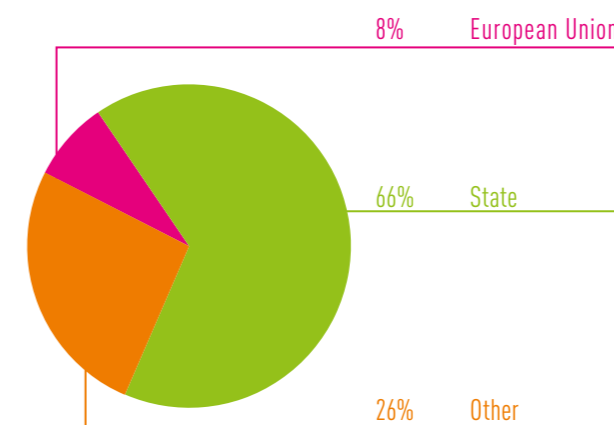
State Secretary Friedlinde Gurr-Hirsch and National Deputy Reinhold Pix with Manuel Hanke-Uhe and Niko Eisenkrämer (from left)

federal funding has decreased considerably and accounts for 1.9 million euro or 66 percent of third-party funds (2016: 74 percent). By contrast, EU funds have risen to 217,559 euros (8 percent; 2016: three percent). Other sources account for 26 percent of third-party funds (2016: 23 percent).

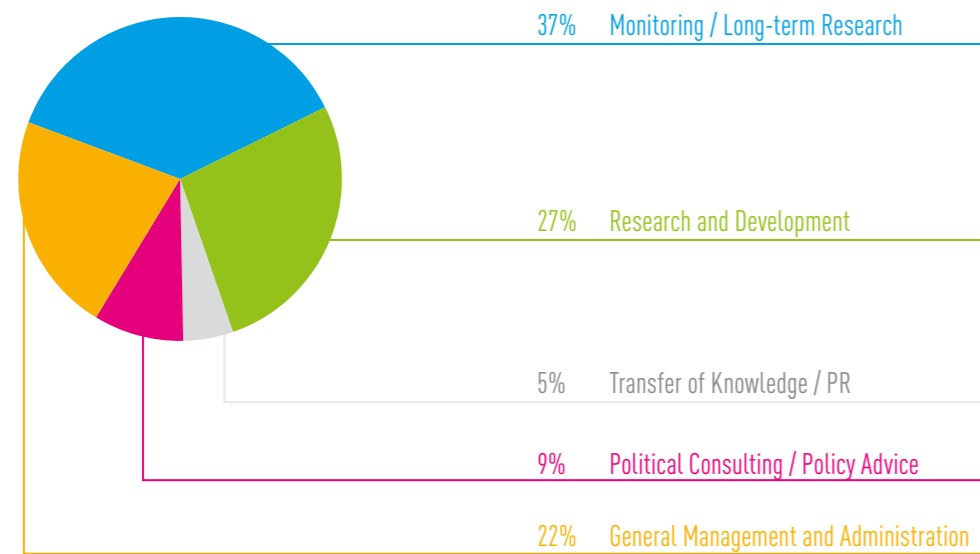
Resources According to Focal Points of Research (15.231.100 €)



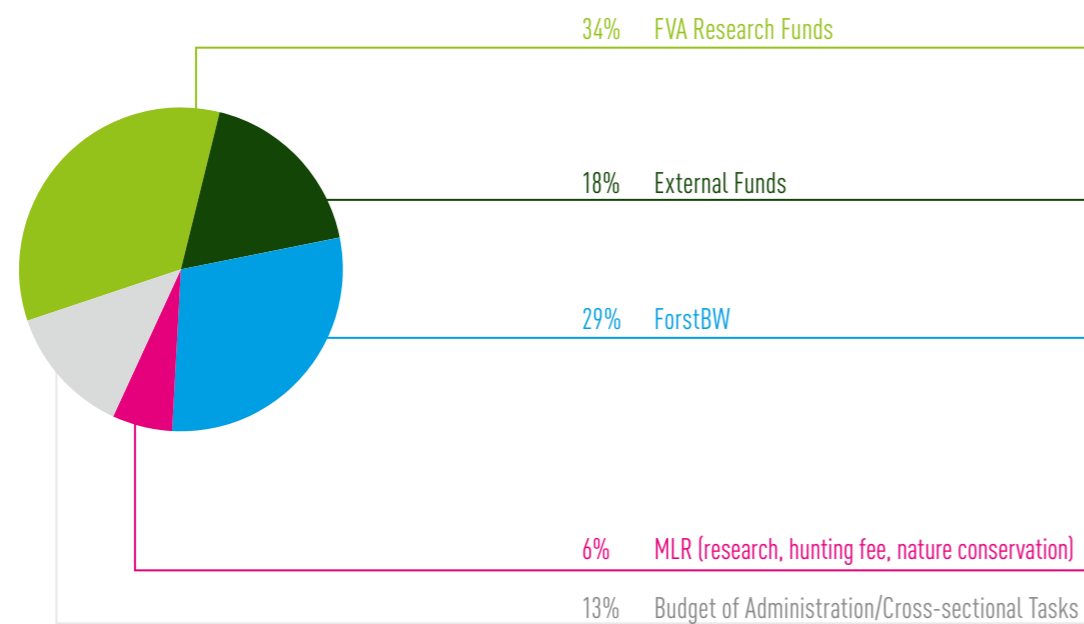
Origin of External Funds (2.807.635 €)



Resources Based on Competency (15.231.100 €)



Resources Based on the Origin of Funds (15.231.100 €)





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