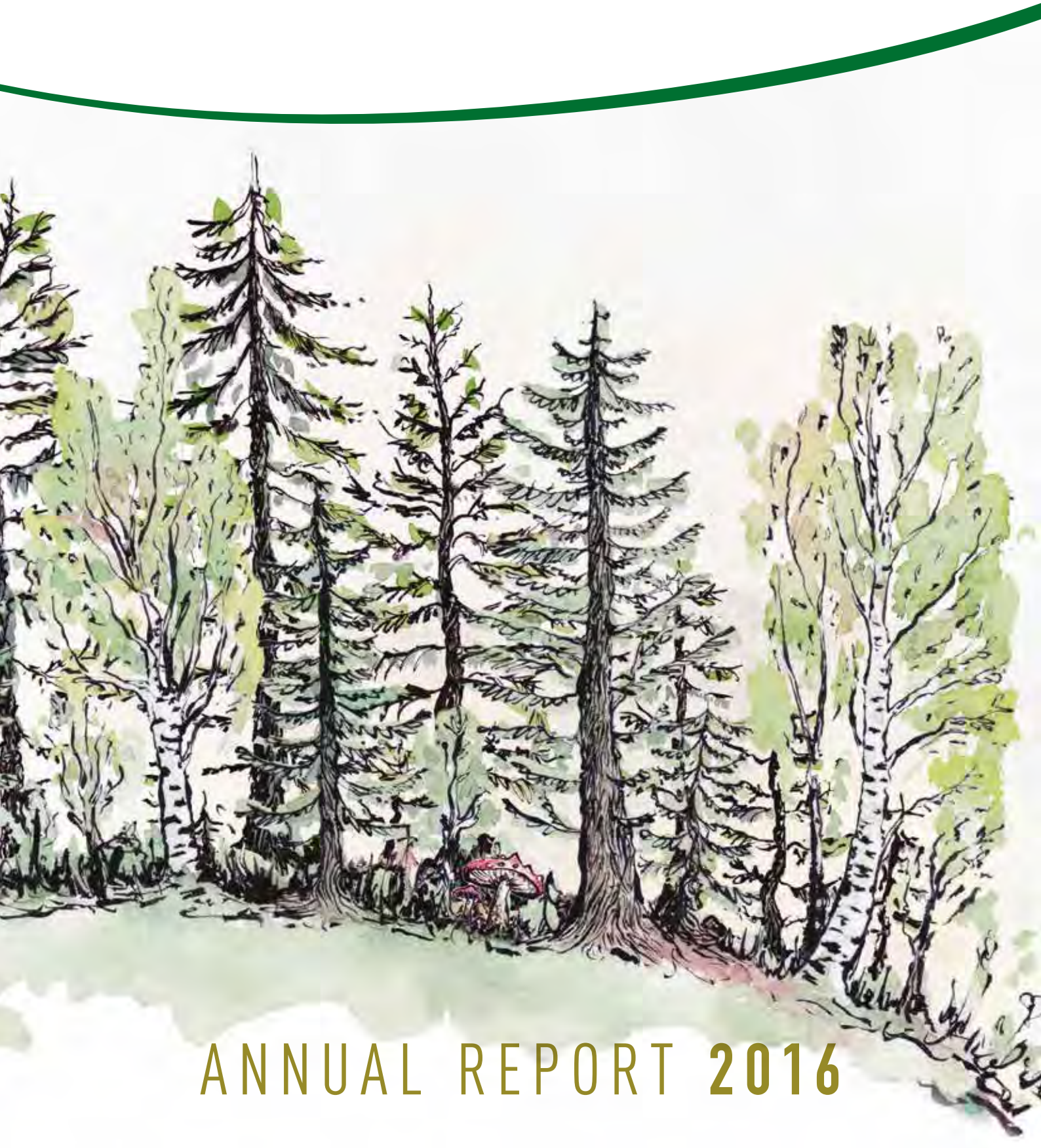
Forest Research Institute
Baden-Württemberg



ANNUAL REPORT **2016**

ForstBW

Baden-Württemberg

ANNUAL REPORT **2016**

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FOREWORD

photo T. Weidner

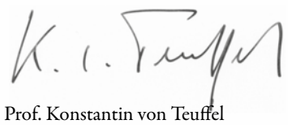
Dear Reader, as an institute for applied forest research, our goal is to provide general practices that are usable from advances in knowledge and technology. In addition to their main work on scientific projects and in forest monitoring, FVA employees are actively involved in other important endeavours such as political consulting, policy advising, and transferring knowledge. Last year, FVA scientists continued to participate in exhibitions and Forest Days, organised workshops and advanced training courses and they also presented their research results as guest speakers at meetings and conferences, as well as in FVA seminars and other events organised by the FVA.

The FVA continuously adds new research topics to its research menu. In many research projects, they closely collaborate with the Faculty for Environment and Natural Resources of the University of Freiburg. At a national level, there are collaborations with other forest research institutes and higher education institutes for applied forest management. In addition, there is a growing number of extensive international collaborations, for example with the research institutes of the three-country triangle forest network, NFZ.forestnet, which was founded ten years ago. Further collaborations include the European Forest Institute and projects in the framework of the International Union of Forest Research Organisations, IUFRO, which will celebrate its 125th anniversary in 2017 in Freiburg. The scientific celebration is organised by the FVA, together with the NFZ institutions from Nancy, Freiburg and Zürich and IUFRO itself.

On the following pages, we have summarized for you our most important achievements and activities of the last year. We also present selected projects in short articles and provide you with some important facts and figures about the FVA.

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,



Prof. Konstantin von Teuffel
Director

FROM THE ADVISORY BOARD


Advisory Board

photo T. Weidner

Dear Reader, it is the task of the Advisory Board to advise and to direct the FVA in its overall development and orientation, and to make recommendations for its strategic focus. In 2016, three strategic research priorities were highlighted in particular: 'Climate change research', 'Forest nature conservation' and 'Measurement and evaluation of sustainability'. In this light, both the current state of research and planned research measures were discussed and assessed.

The Advisory Board views climate change research as one of the most important parts of forest research. Already, the FVA has achieved important results regarding the research question 'tree species suitability and vulnerability under climate change'. The Advisory Board appreciates the close collaboration between the departments in this research field. Regarding forest nature conservation, the Advisory Board intensively discussed, amongst other things, 'natural and anthropogenic open site forests'. In 2017, discussions on topics relevant to forest nature conservation will continue to be developed.

The Advisory Board views national and international collaboration as a necessity for the FVA to be able to position itself in the scientific landscape and to ensure a broad transfer of knowledge. An example is the FVA collaboration with the European Forest Technology Platform (FTP). This Forest-based Sector Technology Platform is a research and innovation platform for the forest-timber-paper sector in Europe and has been successfully representing the interests of the sector in research policies at the European level since 2005. As a national support group, FTP Germany ensures representation of German interests in the FTP, as well as the interests of the forest-timber-paper sector in German research policies. Via its director, the FVA is the coordinator for Germany and therefore an important actor at the interface between research and politics.

An upcoming milestone is the organisation of the 125th anniversary celebration of IUFRO, the International Union of Forest Research Organisations, which will take place in Freiburg in 2017. Through its active cooperation in the research network Nancy-Freiburg-Zürich (NFZ), the FVA not only contributes to the importance of forest research in Germany, but also in Europe and further afield. The Advisory Board sees and welcomes this as further evidence of effective networking between the FVA and the international forest research communities. Preparations for the conference, which is expected to attract more than 2000 participants, are already in full swing.

The traditional autumn meeting of the Advisory Board took place in an unprecedented framework because the meeting was fully dedicated to FVA's strategy. As the FVA has reached the halfway point of its 2014 - 2018 strategic concept, the new information format provided a good overview of the progress that has been made in implementing the existing strategic concept. In addition, various research focus indicators and existing challenges were highlighted that the FVA must meet. As the event had been designed for the Advisory Board members and all FVA employees, there were plenty of opportunities for exchanging and discussing ideas and finding solutions. The board hopes to continue having regular exchanges between all FVA representatives.

This successful event enabled the Advisory Board to discuss a follow-up strategy. Flexibility regarding adapting research focus points to a changing social environment, deploying FVA generated data, transferring knowledge and communicating for optimal value, are all examples of strategic planning considerations. The annual plan as the basis of the FVA working program was presented by the departments and approved by the Advisory Board.

In addition to these strategic considerations, the newly developed principles of FVA's data policy will also be presented to the Advisory Board in 2017, with the aim of finalizing the discussion in a hopefully binding way.

Finally, I would like to say thank you, also on behalf of my Advisory Board member colleagues, for the open and constructive discussions with the director and the department heads, as well as the colleagues representing them. We hope that the external view and recommendations of the Advisory Board will be an opportunity for the FVA employees to explore and evaluate current and possible new roads. We would also like to take this opportunity to thank everyone for the inspiring conversations and exchanges with all FVA employees.

Dr Peter Mayer
Chairman of the Advisory Board

THE YEAR 2016 IN REVIEW

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photo M. Rupp

Field trip to Schwetzinger Hardt with Hans-Gerd Michiels (in front)

In 2016, the general condition of the forests has hardly changed compared to the previous year, due to a wet spring: Norway spruce and silver fir showed little change in crown condition; Scots pine and oak made a slight recovery; only beech showed a decline in crown condition, which can be attributed to repeated heavy fruiting, as well as to late frost in some areas. Additionally, favourable weather conditions helped prevent more extensive bark beetle mass propagation; furthermore, the intensive bark beetle monitoring program, enabling 'clean management' of forests, also contributed to this. Forest protection expertise was also called upon in the areas of ash dieback and the Asiatic long-horned beetle, which is known as a quarantine-classified pest. All of this is documented in the 2016 State-of-the-Forest Report, written by the FVA on behalf of the Ministry of Rural Affairs and Consumer Protection of Baden-Württemberg (MLR).

In the light of the results of the second country-wide soil condition survey, published at end of November 2016, acid pollution has also decreased significantly since the first survey in the 1990s. Heavy metal pollution also decreased, whereas nitrogen inputs remain high.

In 2016, the FVA carried out a mid-term review of its 2014-2018 strategy. Altogether, this looks positive: As a partner for science, practice and politics, the FVA carries out competent, professional research in all areas relevant to forests. FVA networks both nationally and internationally, and collaborates in numerous third party funded projects. It has collaborative agreements with Rhineland-Palatinate (forest protection advice and pest monitoring), with Bavaria (Bavarian Office for Forest Seeds and Plants Cultivation ASP) and with Luxemburg (research of forest reserves). It also engages in extensive collaborative projects within the framework of the International Union of Forest Research Organisations (IUFRO), which will celebrate its 125th anniversary in 2017 with a scientific conference in Freiburg. The FVA is organising the conference in collaboration with the forest research institutes of the border triangle cooperation NFZ-forestnet from Zürich, Freiburg and Nancy, as well as with the IUFRO. More than 2,000 scientists worldwide are expected to participate in this conference.

Climate Change Research

For the research priority "climate change research" the main focus until the end of the current strategy period 2018 will be on assessing parameters for tree species suitability and vulnerability. In this process, the inter-departmental working groups will develop the basics for stimulating the partial criteria for tree species suitability. These partial criteria, for example growth trends, changed mortality and damage caused by drought stress, will then be brought together at the FVA level. This will enable a climate dynamic assessment of tree species suitability, as well as a vulnerability evaluation of the forest ecosystems in Baden-Württemberg with respect to negative impacts of climate change.

Over all in Baden-Württemberg, the balance of the results so far together with climate impact research models, tree species suitability maps dating from 2010, and changes in tree growth vitality regarding their declines and improvements have been analysed on a per area basis. Regarding tree species suitability, all four main tree species assessed show a significant decline in their suitability by 2050. According to this analysis, the suitability of Norway spruce would decline the most. Beech is also expected to show a decline. The suitability of sessile oak would decline the least; thus, it is a relative winner in terms of climate change.

To assess growth changes that may be expected, a site index model sensitive to climate change was used to project growth for the years 2040, 2070 and 2100 for various climate scenarios. This analysis showed that growth decline and loss of productivity can be expected, especially in the second half of the 21st century and in the climate scenarios A1B and A2, which are based on assumptions of high CO_2 emissions. Scenario B1 based on unrealistically low assumptions concerning future CO_2 emissions apparently will not lead to such a decline. The most affected species would be beech and Norway spruce, and oak to a lesser extent; whereas the productivity of Douglas fir and Scots pine would not change significantly. Silver fir was the only tree species we observed showing a clear, albeit very small, increase in site index.

This research priority is also associated with the nationwide cooperation project 'Providing Suitable Forest Adaptation Strategies for the Increasing Potential of Harmful Organisms in Precipitation-Limited Regions Related to Increasing Restrictions' led by the FVA. This project aims to establish forest protection concepts based on selected regions with limited precipitation and increased restrictions for applicable forest protection measures. With Scots pine *(Pinus sylvestris)* and native oak species *(Quercus spp.)*, the focus lies on tree species that on the one hand distinguish themselves by a broad ecological amplitude and high tolerance of climate change, and therefore are viewed as also being important to forest management in the future. On the other hand, however, these are exactly the tree species showing trends that point to somewhat significant forest sanitation impairments.

Floristic documentation: Therese Palm (left) and Maria Barbara Winter

photo: M. Rupp

photo: M. Rupp

Faunistic documentation: Felizitas Werwie

photo: M. Rupp

Marking trees: Nora Magg

The FVA is further leading the joint project "Competence Network Climate Change Crisis Management and Transformation in Forest Ecosystems" (KoNeKKTiW), in which the German Forest Owners' Federation (AGDW), the German Forestry Council and twelve other institutions are involved. The objectives are to transfer knowledge and skills and to elevate an awareness of the need for a forward-looking way of dealing with climate change and the extreme weather conditions connected with it. This project applies the approach of the IPCC (Intergovernmental Panel on Climate Change) that applying research results can only really be successful if a corresponding awareness is created in those who will use these research results in the future. Last year, the completion of a closed methodical concept for risk management in forestry operations and forestry consortia had priority in this regard.

For this research priority, amongst others, the project 'Impact of Structural Diversity in Mixed Alpine Forests on Growth Behaviour' ended. The results from this project bring new insights into how the forests in Baden-Württemberg adapt to the consequences of climate change. It shows in particular that a higher structural diversity increases tree growth. Increase in structural diversity therefore contributes to forest stability and vitality, especially when temperatures rise. In this context, temperature turns out to be the most important climatic parameter for the relationship between climate and growth: In conditions with sufficient precipitation, higher temperatures will lead to higher growth rates. Further results relate to the relationship between species diversity and structural diversity, but also provide information about which diversity indices best explain forest growth under climate change.

Forest Nature Conservation and Biodiversity

Current research projects with a research focus on 'forest nature conservation and biodiversity' include the 'Development of a Concept for Forest Target Species', the 'Concept for Preservation and Restoration of Open Site Forests', 'Consequences of Process Protection on Forest Biodiversity' and the subject area 'Preserving and Securing Forest Wetlands'.

Various projects are working on the concept of forest target species. Forest target species include animals, plants and fungi. In the first subproject, species are selected from each group, which are at immediate risk and for which Baden-Württemberg has a special responsibility, and which are characteristic for the natural habitats and representative of structures and forest ecosystems that are important for forest nature conservation. For these species, habitat requirements, recommendations for actions for improvement and documentation methods are described. The emphasis on the selected species will enable their effective and coordinated protection. Apart from selecting the species, a different subproject is developing an information system to provide relevant information for protecting species and forest management. This will enable integrating species management with forest management and will allow for long-term use of target forest species in the framework of monitoring species as an indicator system for environmentally sound management.

In pilot projects for conservation and restoration of light demanding forests in Baden-Württemberg, characteristic open site forest ecosystems are restored in various corresponding growth areas, for example by mechanical measures or by implementing adapted pasture management with cows, sheep, goats, horses or donkeys. These measures will be monitored and the efficiency of such management systems will also be recorded and assessed. Currently, the regional forest reserve of Schwetzinger Hardt, under governance of the lower forest authority of the Rhine-Neckar district, is a focus area. By means of a care and development plan, the FVA is creating the prerequisites necessary to dedicate this area permanently to open site and moderately open site forest ecosystems. The model project, which the FVA will implement in collaboration with the district forestry office before the end of 2017, also includes fighting neophytes and vegetation surveys that will then be used to evaluate the occurrence and the population development of target forest species.

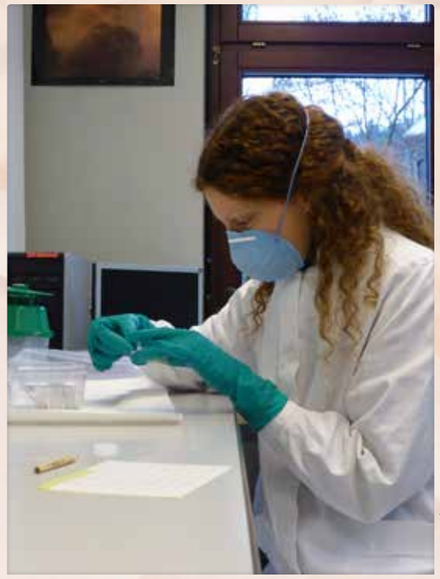
Projects focussing on the impact of process protection on forest biodiversity investigate structural forest development on larger (protective forests) and smaller (habitat tree groups of the old and dead wood concept) areas without sylvicultural exploitation and their impact on selected groups of targeted forest species. Currently, the focus lies on birds and bats (in collaboration with the Swiss Federal Institute for Forest, Snow and Landscape Research WSL and the University of Freiburg). Modules on wood-inhabiting beetles and vascular plants are being prepared. The main research focuses are concerned with the derivation of target values for relevant habitat requisites (especially dead wood, micro-habitats), as well as the question of how species diversity and species-related habitat suitability are related to area size, spatial configuration and the age of process protection areas.

The 'Preserving and Securing Forest Wetlands' project develops standards and guidelines for wetland restoration in the future and applies them to exemplary model projects. In a joint project between Baden-Württemberg and Bavaria the FVA will finalize a compendium on the 'professional wetland restoration in southern Germany'.

For the research priority 'forest nature conservation and biodiversity', the Edge of the Wood project was concluded in 2016. The FVA implemented this project in collaboration with

Working in green house: Karl-Martin Schott

photo T. Weidner



Working in Forest Health Laboratory: Paula Halbig

photo H. Delb

Working in Soil Science Laboratory: Birgit Kelp

photo T. Weidner

Working in green house: Karl-Alexander Gebhardt

photo T. Weidner

the University of Freiburg. In accordance with the project target, a draft of an Edge of the Wood guide was handed over to the MLR. This constitutes an important specialist basis for the corresponding aid policy for Baden-Württemberg. However, in the framework of the overall concept, the results will also be incorporated in a forest edge care concept and will be made available to the expert public. The guidelines help professional forestry companies and nature protection organisations to identify the ecological value of forest edges, as well as potential dangers and development possibilities, and provide basic information for their creation and care.

Amongst other things, the bi-national project for Relinking Habitats in the Upper Rhine area was started in collaboration with the FVA and Southern Black Forest Nature Park. The project is funded by the Federal Agency for Nature Conservation (BfN) with finances from the Federal Ministry for the Environment (BMUB). The purpose of the two-year preliminary study is to create a concept for linking habitats. Following the Swiss model, measures to link habitats should now also be developed and implemented on the German side. The aim is to reinstate the landscape-ecological links of the Black Forest with the Upper Rhine, the Swiss Jura and the Alps, so they will once again be suitable for wild animals, and to secure them for the long term.

Measuring and Assessing Sustainability

The project 'Forest Management 2020 – Information from Remote Sensing Module' falls under the research priority 'measuring and assessing sustainability'. In this project, practical procedures are developed using the help of modern 3D aerial photography technology. These procedures can then be used in the framework of forestry planning. Surface models established with the help of stereo aerial photography provide height information in the form of so-called height structure cards that help forest practitioners with their forest surveys. Furthermore, these surface models can be used as a basis for important parameters for individual items such as wood inventories, height, and tree species ratios. This procedure will make forestry planning more efficient resulting in improved rational opportunities for forest management.

The project 'Forest Planner: Development of Forestry Planning Tools for Forestry Planning' is also being conducted at the same time as the previous project. The forestry planning tool is a computer program that enables updating forest development at strata level, based on the current condition, as described in the forest inventory. Various utilisation scenarios can be created in order to establish the allowable cut in the planning period, organised per tree species and structural strength classes.

With regard to the research priority 'measuring and assessing sustainability', the WEHAM 2012 project was completed in 2016. On behalf of the federal government, the FVA further developed the forest development and wood supply model for the federal forest inventory in the framework of this project. Based on current data from the federal forest inventory, the model provides an overview of potential and sustainable raw wood supply for the next 40 years in Germany, classified according to wood types, ownership and species groups, federal states and other regional structures. Apart from the wood supply, the WEHAM scenarios also provide key indicators for forest development, composition of tree species, age classification structure and wood stocks. The model can also be used for assessing the carbon balance for greenhouse gas reporting, as well as for scientific projects on climate impact (for example for the Forest Climate Fund project on 'forest productivity and carbon storage in climate change'). The FVA has its own assessment capability and carries out corresponding assessments within the framework of federal state specific analysis of the federal forest inventory.

A new project in which the FVA collaborates and that should be completed in the current strategic period, is the EU project 'Diabolo'. The project addresses the harmonisation and integration of national forest inventories at the EU level. In the subfield of remote sensing, the FVA works on developing methods to capture forest parameters from high-resolution remote sensing data, in close collaboration with the National Institute for Agronomics in France (INRA) and the University of Freiburg. This project includes developing procedures to automatically determine inventory heights, coverage ratio, number and size of the tree crowns for the inventory.

photo Y. Chtioui

Forest Day in Konstanz: Axel Albrecht (right)

photo A. Albrecht

Forest Day in Konstanz: Yvonne Chtioui (right)

photo R. Bogenschütz

KWF Trade Fair in Roding: Uli Riemer on the podium (2. from left)

Building on these methods, models are developed to help make statements concerning smaller areas, based on federal forest inventory data.

Research in Action

The FVA was met with significant interest from the professional public through its regularly held seminars, workshops and other small and larger events. In collaboration with the Federal Agency for Nature Conservation and the Julius Kühn Institute, the FVA organised a three-day event in Freiburg at the end of November/beginning of December. This 'Invasive Species in the Forest' event attracted about 140 participants from all relevant forest, nature and plant conservation fields in Germany and neighbouring countries. The FVA also participated in various areas of the forest scientific conference 2016 that took place at the end of September in Freiburg and attracted around 550 participants. In addition to organising and presenting various program elements, many FVA scientists enriched this attractive program with their presentations.

FVA research again attracted a lot of interest from the media. This particularly applies to themes such as wild animal ecology (lynx, wolf, wood grouse), forest health (bark beetles, ash dieback, Asian long-horned beetle), forest nature conservation (open site forests, fighting pokeweed) and climate impact research (weather and tree growth) and was expressed in the growing number of press, television and radio items about FVA research results.

And finally, FVA researchers also made their research realizable to the broad public: In collaboration with the 'House of Nature' and the 'Nature and Biodiversity Conservation Union' (NABU), the FVA organised the first 'Feldberg Bird Day' in early June, including various excursions in the nature reserve, a long hike and hands-on activities for children. The FVA was also heavily represented at the forestry trade fair of the Board of Trustees for Forestry Work and Technology (KWF) in June in Roding. Topics included the use of drones in forestry, careful mechanical harvesting of coniferous wood logs, access to sensitive locations, use of innovative approaches for sorting and measuring wood in the future, as well as participation in the connection with the Overall Concept for Nature Conservation in Forests of the ForstBW. The FVA involvement was also prevalent at the 'Big Forest Day' in Schwetzinger Hardt in September, with the topics 'Sociocultural Forest Monitoring', 'Urban Forest Management' and the pilot project for fighting neophytes. FVA staff also participated in the Forest Day in Konstanz in September: There, they provided easily understandable information about wild animal accidents and biotope networks, green bridges that help wild animals cross over to different areas and illustrated effects and risks of climate change. Finally, the FVA was co-organiser of the 'Red Deer Days' in the red deer area of the Southern Black Forest in October, and additionally held an experts' conference about red deer (see also reports in FVA-einblick 2 and 3/2016).

Further selected FVA projects will be presented in summarized form hereafter. An overview of current FVA projects and projects completed in 2016, as well as detailed information about other FVA activities, events and publications, can be found on www.fva-bw.de.

THE EUROPEAN WILDCAT IN THE UPPER RHINE VALLEY AND REGION „KAISERSTUHL“ – Its Spatial Organization in a Highly Fragmented Landscape

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Since 1912, the European Wildcat *(Felis silvestris silvestris)* was considered to be extinct in Baden-Württemberg for almost a century. In 2006 and 2007 two carcasses were found in the Upper Rhine Valley and genetically identified as pure wildcats. Ever since, continuous evidence of its occurrence has been found. The known occurrence of the wildcat in Baden-Württemberg mainly ranges from Lörrach to Karlsruhe along the Upper Rhine Valley. Sporadic evidence has been found over the whole state indicating either solitary dispersing individuals or small groups resulting from recent dispersals from the Upper Rhine Valley or from neighboring populations in Bavaria or Switzerland.

In Germany, wildcats inhabit areas with contiguous forests. Their core distribution is mainly in the Pfälzer Wald, the Eifel and the Harz region. In contrast, the Upper Rhine Valley represents a highly-fragmented landscape with intensive agriculture and a high density of roads and human settlements with only small forest patches along the Rhine River.

Between 2010 and 2015, a research project was conducted in the Kaiserstuhl region and adjacent floodplain forests to investigate the spatio-temporal behavior and habitat use of wildcats in the patchy forests using GPS-telemetry. Furthermore, the connectivity to wildcat populations of neighbouring countries (France and Switzerland) was studied using genetic analyses to gain information about the origin of this recolonizing population.

Twenty-one individuals were captured in wooden live-traps and fitted with GPS collars. For genetic analysis, a blood sample was taken. The periods in which the wildcats could be observed via telemetry ranged between two weeks and almost two years. The short periods are due to the loss of the collar or the death of the individual. Most of the individuals were captured twice in order to remove the collar.

Space Use of Wildcats in Higly Anthropogenic Cultivated Landscape

The results of the telemetry study suggested that wildcats were able to occupy habitats in the sparsely forested cultural landscape of the Upper Rhine Valley. However, wildcats' habitat use was limited almost exclusively to forested areas or places with a high proportion of shelter. Spatial organization of the collared individuals within the study area was comparable to other studies. However, home range sizes were smaller compared to those reported in studies in contiguous forests in Europe. Reasons for smaller home ranges in the floodplain forests could be explained by the high structural diversity and high prey abundance within the study area.

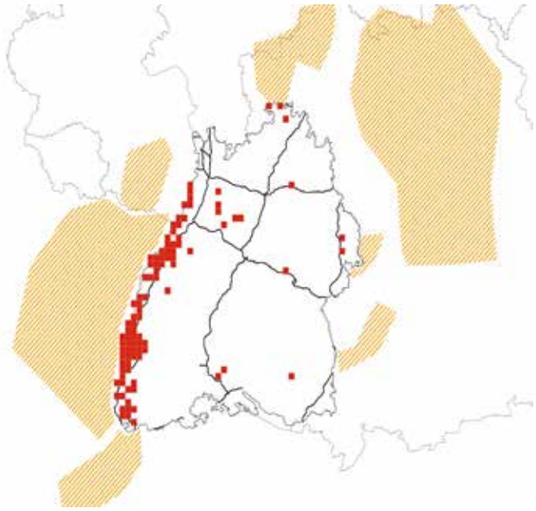
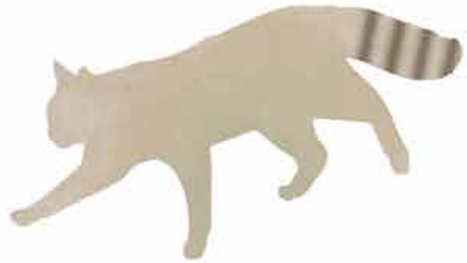


Figure 1: Distribution of the European wildcat in Baden-Württemberg and bordering areas (2016)



Male wildcats especially were less restricted to forested habitats and were frequently found in open landscape habitats along field margins and hedgerows. In contrast, the use of open landscape habitats by females was very rare and no agricultural areas were traversed. The results of the study also emphasized the threat of roads, especially in fragmented landscapes where road density is high. Three of the collared males as well as seven unknown wildcats (which were detected within the monitoring program) were killed by cars.

Recolonization of the Wildcat

Genetic analyses show that there was no genetic differentiation between individuals of the Upper Rhine Valley and individuals inhabiting the Vosges (France) and the Jura Mountains (Switzerland). Thus, we can assume that the Rhine River did not act as a barrier and both populations were sufficiently interconnected to facilitate adequate dispersal and gene flow. The lack of wildcat occurrence outside the Upper Rhine Valley and the genetic attributes of the two populations support the hypothesis that the wildcat was extinct in Baden-Württemberg and has recolonized its former habitat in recent years.

photo K. Echle

Figure 2: Wildcats were captured in wooded traps and were tagged with GPS-collars to study their habitat use.

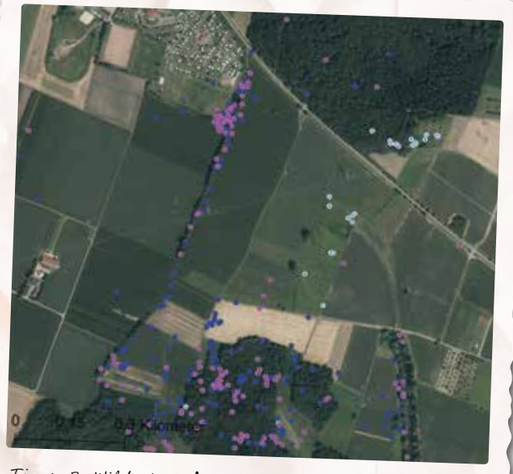


Figure 3: Wildcats prefer high structural cover to cross open plains and agricultural areas. The dots illustrate the telemetric position findings of three male wildcats.

We found introgression in the wildcat population of the Upper Rhine Valley to be ten percent. A small proportion of hybrids in a population is often detected after dispersal events and can even facilitate colonizing new habitats. Therefore, the small hybridization rate was not considered as a threat, but for a successful recolonization of the wildcat in Baden-Württemberg, hybridization processes need to be monitored in the long term.

Conclusion

The highly-fragmented landscape in the Upper Rhine Valley shows that it can be suitable habitat for a wildcat population. However, the success of a long term recolonization of its former habitat is highly dependent on the structural diversity in forested areas as well as the connectivity of those habitats.

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SCIENTIFIC RESEARCH AS A BASIS FOR RED DEER MANAGEMENT CONCEPTS

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Red deer *(Cervus elaphus)* are the biggest free roaming herbivores in Germany. Thus, it is essential to manage such populations on a large scale. However, managing red deer is difficult due to the various types of forest ownerships, small scale hunting grounds, and inconsistent handling of game winter feeding sites. Additionally, unorganized tourist activities and poor communication, as well as different personal objectives and values of users are further obstacles to effective management. This leads to both (often preventable) damage caused by red deer and lack of acceptance of effective management plans by resource users.

Many conflicts and their negative consequences could be avoided or at least be reduced by managing red deer across hunting grounds and by including all groups of affected people in the process of developing and implementing management actions. Management must account for both wildlife and social science research to consider simultaneously the ecological demands of red deer and the needs of the local human population for recreational use of red deer habitat (Figure 1).

Therefore, it is important that:

1. damage caused by red deer stay within limits set by land owners,
2. red deer habitat needs are being met and enough areas of refuge are available,
3. red deer density accounts for conditions mentioned above (# 1 and # 2) but if the density is too high, the population should be reduced,
4. hunting of red deer remains attractive with a high positive hunting value,
5. red deer is visible in selected areas for the public to see,
6. nature conservation and animal welfare goals are ensured, and
7. long-term management structures are being established, so that resources for implementing management actions and the ongoing development of the management concept are available.

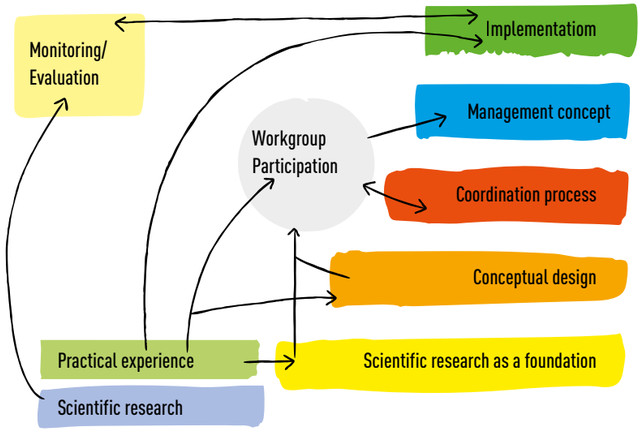

Figure 1: Steps in developing a management concept

Based on these specifications, the Forest Research Institute of Baden-Württemberg (FVA), in cooperation with the "Arbeitsgemeinschaft Rotwild" (Red deer workgroup), has developed a management concept for the red deer territory "Southern Black Forest". The concept is based on extensive research conducted prior to the development process and includes, for example, a change in hunting methods and measures to increase habitat quality. Subsequently, the FVA has started a new project ("Erfolgskontrolle Rotwildkonzeption Südschwarzwald") to evaluate whether implementing the management concept has been effective. A new method that uses genetic analysis of fecal DNA obtained from an area of 8000 hectares was employed to estimate and verify red deer population size. Furthermore, the habitat survey of 2006 was repeated in 2016 to evaluate changes in habitat quality.

Initial results show a positive change in food availability and cover provided by vegetation. Therefore, the measures used to increase habitat quality have proven to be effective. In 2017, the project will focus on the social science part of the project, which includes all relevant stakeholders. Interviews and surveys will be used to determine the attitudes and desires that different stakeholders have about the management concept. This information will enable us to anonymously identify potential improvements to the concept. The management concept will be revised by the end of 2017 using the resources of Arbeitsgemeinschaft Rotwild.

Aside from evaluating the management concept for the southern Black Forest, the FVA is currently developing a concept for the red deer territory "Northern Black Forest". The red deer territory "Northern Black Forest" (105.000 hectares) is the largest of five red deer territories in Baden-Württemberg and plays a key role in migration and genetic exchange within red deer populations. More than 85% of the area is covered by forest, most of it being in state forest or municipal forest. The red deer territory is embedded in the Naturpark Schwarzwald Mitte-Nord and covers 7 counties and two administrative districts. To complicate things even more, the red deer territory contains over 250 hunting grounds and the Black Forest National Park.

During the next few years, wildlife and social science research will be undertaken to develop a management concept extending to 2020. Using radio-telemetry, up to 30 red deer will be observed over two or more years to identify spatio-temporal habitat use and migration. Genetic monitoring, the analysis of the yearly hunting bag, and trail cams will be used to quantify the size and development of the red deer population size. Vegetation surveys and the analysis of inventory and remote sensing data will be used to determine seasonal habitat quality. A newly developed bark stripping monitoring method will be used to monitor damage caused by red deer. Furthermore, interviews and surveys will be used to determine attitudes and desires of various stakeholders on the management concept. The research methods we are employing should reveal how attitudes and desires change during the development process. In collaboration with the FVA and based on the information obtained from the various research project groups, local stakeholders will form working groups who then will develop the actual management concept.

MONITORING HARMFUL ORGANISMS
in Southwest German Forests

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Monitoring pests and diseases is a crucial task of the Department of Forest Health. It is fundamental for effective pest and disease management. It provides information about when, where and to what intensity pest and diseases are to be expected. Moreover, we assess the risk potential for tree species that we are concerned about. Regarding specific organisms, we also assess health impacts of forests on people working or recreating in forests.

Characteristics of Monitoring

The spatial and temporal dimensions as well as monitoring intervals vary depending on specific requirements. For instance, various methods are used depending upon an organism's biology. Notifications about the occurrences of biotic forest pest and diseases as well as abiotic disturbances such as storm damage need to be provided over the long term by local foresters. The areal extension, the intensity and the amount of damaged timber are of special interest. Additionally, relevant long-term monitoring systems are necessary with respect to tracking important harmful organisms.

The monitoring of spruce bark-beetle is of very special interest, which must be conducted particularly during the vegetation period. The Eight-toothed European bark beetle is of special concern because it can cause major damage to the forest. This is due to its potential for developing several generations per year yielding subsequent offspring and sibling broods within the same year. Depending on the prevailing initial conditions, the size of population in the spring, the availability of host material resulting from disturbances such as heavy snowfall or windstorms as well as the course of weather, mass propagations can arise very quickly. To assess changes in forest structure in the Upper Rhine valley it is essential to take the development of the forest cockchafer population into consideration. Also in the context of ash dieback, systematic surveys of disease development reveal decisive information useful for making management decisions.

For some forest pests, such as the Gypsy moth, monitoring is run in a two-stage process. First of all, pheromone trap-catches indicate when there is an alarming increase in the population. If these trap findings match notifications from local foresters, the next stage is to count egg masses using a systematic grid sampling method to obtain a precise prognosis. The measured abundance is then compared to critical numbers that are used to predict damage depending on certain environmental circumstances like weather conditions.

The monitoring of forest pest and diseases is basically supported by recording weather data as well as documenting timber damaged by abiotic disturbances such as heavy snowfall or windstorms and biotic pest infestations. Temporal and spatial correlations among these data in particular but also information gained from forest inventory or site mapping are fundamental for competent scientific analysis, interpretation and assessment. This competency is crucial for an appropriate risk assessment as a part of advising forest managers and supporting their decision-making process to employ certain forest practices. This approach is in line with the principle of best practices for integrated pest management. As a result, the necessity and adequacy of preventive or curative measures can be better evaluated. Moreover, these recommendations are important factors for silvicultural and operational decisions. Furthermore, these data are very valuable for scientific purposes primarily when evaluating time series.

photo H. Delb

Norway spruce logs as catch for monitoring the bark beetle brood behavior

Figure 1: Monitoring and Prognosis, a crucial field of activity of the Department of Forest Health

Invasive Alien Harmful Organisms and Quarantine

Due to globalization and climate change the risk of introduction, immigration and establishment of alien and thermophilic organisms harmful to plants or plant products is increasing. That is why with respect to monitoring, demands and tasks have increased in recent years. Within the EU the obligatory specific monitoring program concerning several potentially alien harmful organisms has become substantially expanded. As a consequence of current evidence of introductions such as the Asian long-horned beetle, Dothistroma needle blight or Chestnut gall wasp additional mandatory phytosanitary emergency measures had to be carried out immediately.

Legal Principles

In accordance with the administrative order regulating competences in agriculture, in its current version, the FVA serves as a plant protection service to forestry. The monitoring of pests and diseases is a significant part of these central functions. In terms of pests and diseases, forests and forest products must be monitored and their occurrence and distribution appropriately reported. Moreover, the FVA, as a government-run institution, must provide a generally free of charge advising service for forest owners as demanded by the "National Action Plan on Sustainable Use of Plant Protection Products".

photo H. Delb

Monitoring May beetle emergence: Manfred Dick

Transfer of Information

The outcome of the monitoring program is presented in annual forest health reports, newsletters about bark beetle or oak processionary moth, on webpages as well as fact sheets or warning messages. As a next step, the system of data acquisition will be basically revised. In the future, reports from local foresters will be relayed digitally without any need of media change. Substantial advantages arise from geo-referenced and the timely supply of data.

Future Prospects

A meaningful monitoring system requires continuity and permanence. However, the methods of monitoring and prognosis of pests and diseases need to be constantly evaluated and adapted to the ongoing changes of requirements. This is especially relevant in the context of climate change and the growing risk of introduction or immigration of alien harmful organisms and as such the importance and efforts of monitoring will continue to increase.

photo H. Delb

Controlling winter moth pasting trap rings: Ricardo Rivero

photo R. John

Quarantine Organism Monitoring Team 2016 (from left): Jan Wupler, Isabelle Chasignet, Dominique Bednarek, Ricardo Rivero, Sarah Mitze, Jörg Schumacher, Michael Schaub, Manuel Hanke-Uhe and Niko Eisenkrämer

THE HABITAT TREE AND DEADWOOD CONCEPT - A Thorough Checkup

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The Habitat Tree and Deadwood Concept (in German AuT concept) of Baden-Württemberg has been implemented since February 2010. In the state forest its implementation is mandatory, in the municipal forest it can be implemented voluntarily. This concept originated in 2008 by the Department of Forest Nature Conservation, together with the Ministry of Rural Areas, the Regional Office for Environment, Measuring and Nature Conservation (LUBW), practicing species specialist, the Forest Bases of ForstBW as well as the Department of Forest Protection. The aim of the AuT concept is to create and accumulate a network of habitat and deadwood structures as an important contribution to the biodiversity conservation in managed forests. To achieve this aim, the AuT concept comprises two different elements that are selected and conserved within this concept: Groups of about 15 habitat trees (mainly old and already microhabitat-bearing trees) (in German: Habitatbaumgruppen = HBG) and small areas of one to three ha (in German: Waldrefugien =WR).

In addition to annual reports, which document the quantitative achievements, in the frame of the FVA-project „AuT evaluation", the qualitative achievements will be considered for the first time in order to determine the ecological effectiveness of the AuT concept. Moreover, nature conservation efforts will be evaluated and made more visible. This comprises a template for a long-term monitoring system that has a scientific basis.

Within the project following steps are planned:

1. Evaluating the occurrence and dynamics of nature conservation relevant structures (e.g. number of habitat trees, microhabitats, deadwood) as well as their importance for the protection of biodiversity.
2. Evaluating the function of the AuT elements as stepping stones and in their spatial connectivity.
3. Evaluating the occurrence of the species within and in the areas surrounding the AuT elements.
4. Assessing the success of the AuT concept as a provisions-concept for species protection.
5. Evaluating the economic effects of the AuT concept for the Forest Service (this will be done by the Department of Forest Economics) (s. article page 27).
6. Developing a long-term monitoring system.

In terms of ecological and economic evaluation, more detailed information was needed than the data collected by the district managers in the designated HBGs (available via FOKUS). In order to meet the requirements for a valid evaluation, a pilot study was carried out together with the Department of Forest Economics. For this purpose, 100 HBGs were selected at random and characteristics were recorded, which were additionally necessary to answer ecological as well as economic questions (fig. 1 and 2).

Figure 1: Clear demarcation of the HBG for data acquisition

photo: J. Schultze

Figure 2: Andreas Schabel and Christina Baumhauer measuring and recording the diameter at breast height (dbh), microhabitats and other tree characteristics within a HBG

photo: J. Schultze

Initial Results

First, a quantitative evaluation was carried out on the implementation of the AuT concept. We checked whether the number of AuT protection elements and their size had been implemented in accordance with the AuT concept. We found that the number of the implemented HBGs was above the expected value. However, the HBGs with an average of 10.9 trees were smaller than the size of 15 trees / HBG like it is required in the AuT concept. WR have an average size of 3.1 ha. This shows that with respect to this AuT element, the expansions of larger areas were the rule rather than the intended 1 to 3 ha.

Based on the FOKUS data we showed that in total, 40% of the 188.563 trees had a diameter at breast height (dbh) over 50cm and 32% of the trees had at least one microhabitat. Based on the data of the pilot study, a significant correlation of the dbh and the occurrence of microhabitats exists: as dbh increased the number of microhabitats also increased.

Cavities, standing deadwood and injuries and wounds are the most occurring microhabitats. But also, rare and specialized species relevant microhabitats like mould cavities or very old trees (over 200 years) were found within 10% of the HBG. Besides dbh, age is an important parameter for promoting the occurrence of microhabitats (Michel and Winter 2009, Voidot et al. 2011, Larrieu and Cabanettes 2014). Old trees (over 180 years) are present in 4% of the HBGs (fig. 3). Furthermore, the largest part (73%) of the trees within the HBG is older than 100 years and is projected to grow into higher age classes because of protection within the HBG. This potential presents a great pool for future (for the most part already existing)

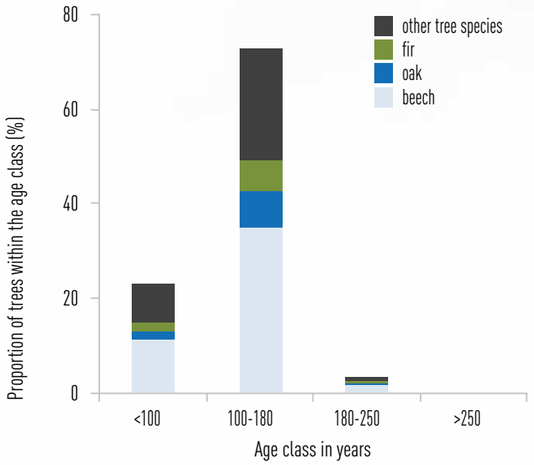

Figure 3: Distribution of the age classes of the trees within the HBG

trees with valuable microhabitats.Deadwood is one of the main structures with very specific habitats, which contributes enormously to the conservation of biodiversity (Müller and Bütler 2010). In total 69.5m³ of deadwood was recorded. This was substantially higher than the average within the managed forest which had 28.2m³ of deadwood/ha (third national forest inventory (BWI). In other unmanaged forest areas of the state forest an average of 76m³/deadwood/ha was found. This showed that the HBGs contribution is an important stepping stone for the network of deadwood.

Conclusion and Next Steps

The quantitative evaluation of the AuT concept and the conception of a monitoring are still in their early stages. But already it is apparent that the conservation of ecological valuable microhabitats contributes to the conservation of biodiversity. Additionally, the microhabitats within the HBGs and WR will be increasing and new ones will develop.

Moreover, we assume that the results from this work will be of wide interest beyond the State of Baden-Württemberg. Next, the AuT concept as a species protection instrument will be evaluated within the evaluation project, as well as deepening evaluations regarding the criteria of threat, representation, rarity and connectivity. The forest refuges will also be included more intensively in the evaluation next year. In addition, the basis for monitoring is to be set up next year, which assesses the effects of the AuT concept on forest species and biodiversity.

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INCOME LOSS AND WORK SAFETY OF THE HABITAT TREE GROUPS

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Since 2010 habitat trees, habitat tree groups (HBG) and small-scale forest reserves have been designated and protected in the Baden-Württemberg state forest, as part of the Habitat Tree and Deadwood Concept (AuT). This concept is part of the state-wide overall forest nature conservation program.

The protection of forest areas for nature conservation inevitably results in a reduction of productive forest land and economic losses. Furthermore, the area covered by these protected HBGs, which accumulate deadwood, lie primarily in production forest areas, which are close to their final harvest, thus influencing work safety (ForstBW 2015).

In a joint study by the departments of Forest Nature Conservation and Forest Economy of the FVA, 100 randomly selected HBGs in the Baden-Württemberg state forest were analyzed. Ecological and economic parameters of HBGs and single trees were collected. The position of boundary trees was documented for calculating HBG areas.

Economic consequences result from a variety of factors:

1. Production loss
By conserving certain areas, the standing stock and the continuing increment must be depreciated operationally. The method by Möhring et al. (2006) to calculate this production loss has become the standard operation, in which the annual production loss is calculated in Euros/hectare. In economic terminology, this is called an annuity, which is the annual equivalent to the net present value of a cutting cycle.

This concept of timber production value incorporates operating expenses such as planting and silvicultural measures as well as logging costs. Timber production value is significantly determined by tree species, site class and the amount of natural regeneration. The areal size of the HBGs and the exact tree species composition are crucial to calculating the value.

photo: M. Herz

Figure 1: Niclas Aleff in well-marked Habitat Tree Group

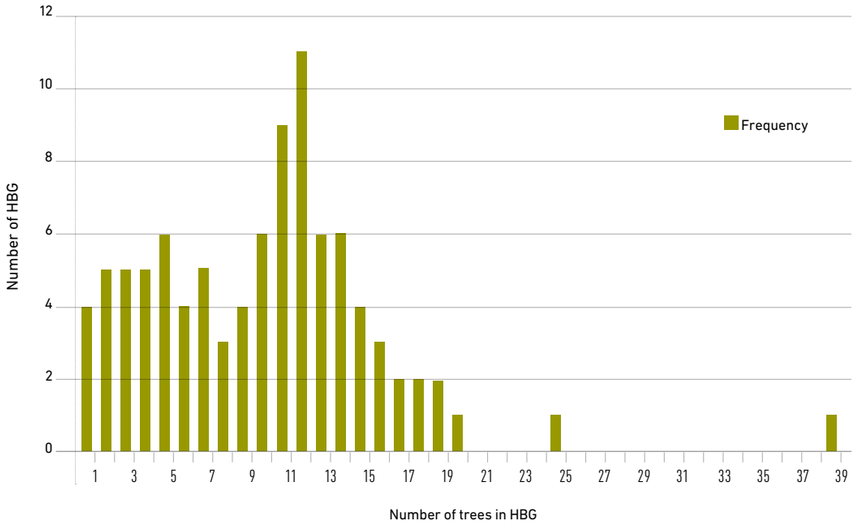

Figure 2: Distribution of tree numbers per HBG

2. Increased administrative costs
Selecting and marking of HBGs are additional duties that must be included into the daily routine of foresters. Results from other related studies lead us to assume that considering conservation issues in forestry increase administrative costs (compare article from project VIWALDI in ForstBW intern 4, 2016, page 20.).

3. Increased administrative costs
The enrichment of deadwood, which still causes accidents in today's forestry, leads to conflicts between work safety and conservation. Therefore, work safety must be considered when assessing the concept of enriching deadwood. Moreover, work safety may lead to additional expenses in education, administration and operational costs.

Composition and Size of HBG

An HBG supposedly consists of one or several habitat trees, which are surrounded by additional trees, ergo in sum approximately 15 trees (ForstBW 2015). However, our results show that the target value of approximately 15 trees per HBG has not been achieved yet. The actual average number of trees per HBG is near 11. The current distribution of tree numbers per HBG is shown in figure 2.

Using the data that we collected, we calculated area under crown cover using a convex polygon at the root collar, where the crown cover radius of the boundary trees was added. This resulted in an average HBG area of 582m².

Costs of Production Loss

To calculate production loss, the amount of natural regeneration (NR) was presumed to be 70%. This together with tree species composition, determined by the area in proportion to its crown cover, resulted in a calculated annuity value of €107.43 per hectare for the HBG areas. Assuming 600m²/HBG, this is approximately €6/year/HBG, which can no longer be generated from forestry production. Extrapolated from the target value of 2300 hectares of HBG-area, production loss adds up to a consistent €250,000 per year. As stated previously, this is only a small proportion of the effective total costs.

Work Safety and Work Coordination

Aside from data collection on site, three experts were interviewed on how the AuT concept should be evaluated from the perspective of work safety. Therewith it became clear that the topic of work safety had already been playing a key role during the design of the AuT and that this led to concentrating one HBG per three hectares (ForstBW 2015). This assumes that an HBG takes on an accumulating function. Outside of the HBG minimizing dead wood can be targeted, while these structures occur more inside the HBGs. At the same time, we previously stated that this effect only applies if the groups can be identified clearly and from a distance.

This assumption was contradicted because 14% of the HBGs could not be found by our employees, despite having access to GPS-data. There could be various causes that are responsible for this, but faded markings certainly played a key role (Fig. 3). Unrecognizable HBGs are neither protected from silvicultural measures nor are there any markings that warn even of the existence of an HBG.

The investigation of the distances of the HBG to the skid trails shows that only 9% of the HBG have contact with the skid trails, but it is impossible to differentiate the locations of skid trails from HBGs. In 40% of the cases skid trails have contact to HBGs; another 32% the skid trails lie closer than a tree-length distance from it (fig. 4). Thus, we assume that harvesting will take more time and the risks will be higher when there are increasing amounts of dead wood in the HBGs.

In summary, the production loss of the HBG is noticeable and should be considered together with the other costs of the AuT in resource planning. The designation of the HBGs has positive effects on work safety, but it is dependent on good visibility of the markings. Concentrating on a few major HBGs is desirable not only in terms of work safety, but also for cost reasons as well.

Table 1: Annuities of tree species and the average HBGs

	Annuity at 100% planted	Annuity at 100% NR	Annuity at 70%NR/ 30%planted	Percentage tree species	Annuity per tree species
	[€/ha/Jahr]			[%]	[€/ha/Jahr]
Beech	16	108	680	75	60,30
Oak	-158	105	26	11	2,87
Spruce / Fir	335	368	358	12	42,97
Pine / Larch	-44	111	64	2	1,29
		Annuity of HBG area			**107,43**

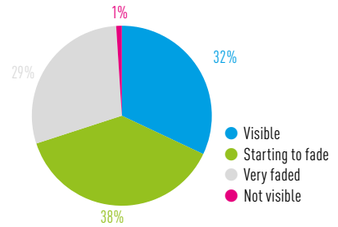

Figure 3: State of HBG markings

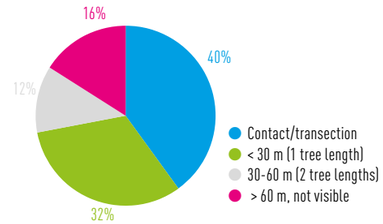

Figure 4: HBGs and skid trails

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GROWTH PERFORMANCE OF INTRODUCED TREE SPECIES IN BADEN-WÜRTTEMBERG

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Background

The state forest of Baden-Württemberg has been managed for decades according to the principles of close-to-nature forestry, which includes the prioritisation of native tree species. Inversely, this implies a purposeful bias against introduced tree species. However, when considering climate change, the long-term suitability of native tree species may be questionable. The experimental cultivation of introduced tree species has a long tradition in Baden-Württemberg. Beginning in 1840 such plantations were started in the former forest district of Güglingen. More extensive trials were installed in Nagold, Weinheim, Breisach and Reutlingen. Generally, the impetus can be traced back to the commitment of individual officers, and their continuance was strongly dependent on the interest of their successor, so that the data quite often did not fulfil scientific standards.

Compared to these practice trials, the experiments with introduced tree species that are available at the department of growth and yield of the FVA have the advantage of continuous documentation and exact data recordings. To scrutinise the suitability of these data from a statistical point of view on one hand and to get an idea about their growth performance on the other, these experiments were recently analysed, and their growth performance compared to that of the main tree species located in the direct neighbourhood of these experiments.

Data

The data base comprises more than 350 experimental trials with 40 introduced tree species. For scientifically sound conclusions, the data had to satisfy certain defined requirements, which was only the case for 15 tree species (fig. 1). Reliable

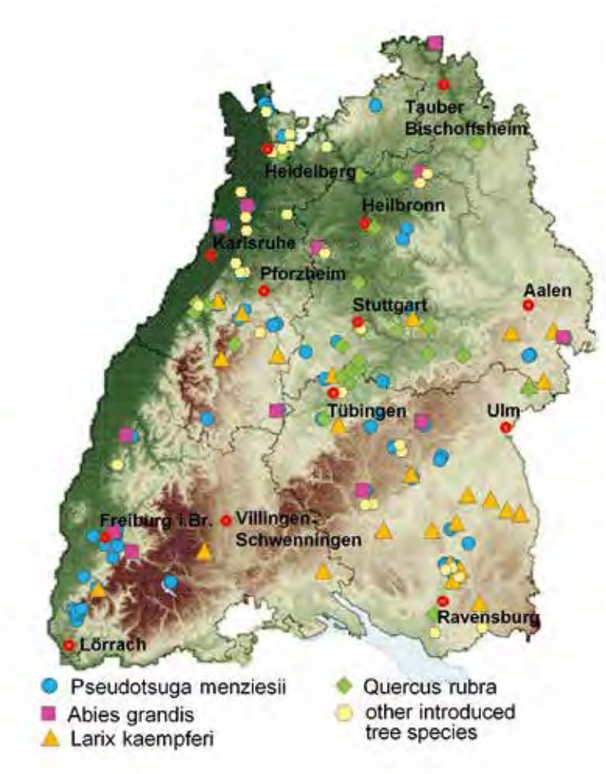

Figure 1: Position of the experiments with introduced tree species in Baden-Württemberg

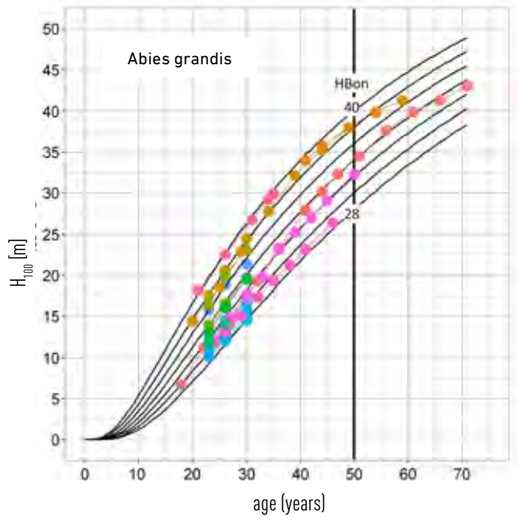

Figure 2: Top height development of Abies grandis and top height site index curves (reference age 50 years)

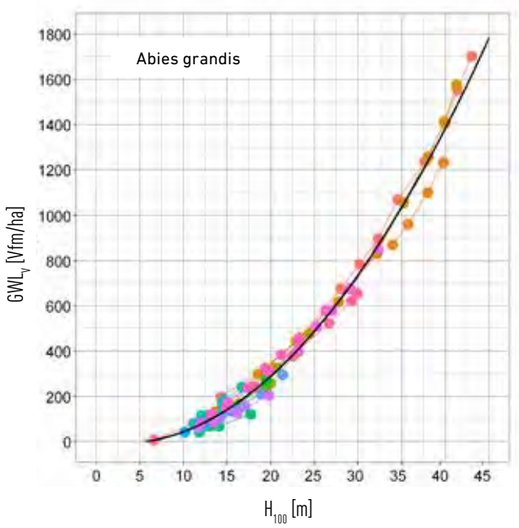

Figure 3: Total volume production versus top height of Abies grandis

data are available for *Pseudotsuga menziesii*, *Quercus rubra* and *Larix kaempferi* with 67, 49 and 40 experimental plots respectively. For *Abies grandis*, *Picea sitchensis*, *Thuja plicata*, *Chamaecyparis lawsoniana* and *Pinus nigra* between 10-17 experimental plots could be used in the analysis, whereas there were only for four to eight plots of *Carya ovata*, *Pinus strobus*, *Abies nordmanniana*, *Picea omorika*, *Sequoiadendron giganteum*, *Juglans regia*, and *Liriodendron tulipifera*. The principle relationships between age and top height as well as between top height and total volume production that were found for these tree species are therefore only of limited validity.

Results

Using experimental data for each tree species, regression analyses were performed on top height versus age and total volume production versus top height. The resulting equations allowed us to construct top height and age related site index curves on one hand and the yield comparison of some of the main tree species (comparative tree species) on the other. For example, the site index curves of *Abies grandis*, plotted together with the top height development of the experimental plots, are presented in figure 2. Figure 3 shows the relationship between total volume production and top height. For *Abies grandis*, *Larix kaempfferi* and *Quercus rubra* the existing top height- and total volume increment relationships could be updated and improved; for other tree species, this relationship was made available for the first time.

The yield comparison shows that *Abies grandis* and *Pseudotsuga menziesii* are clearly superior to the comparative tree species regarding the top heights reached at the reference age (fig. 4) as well as the total volume production (fig. 5) (with *Abies grandis* being slightly superior to *Pseudotsuga menziesii*). Whereas the top height site index of *Larix kaempfferi* under similar growing conditions is comparable to *Picea abies* and *Abies alba*, total volume production is significantly lower. *Picea sitchensis* and *Abies nordmanniana* lag behind *Picea abies* and *Abies alba* in terms of site index and total volume production. Regarding both parameters, *Quercus rubra* equals the level of *Fagus silvatica* and is superior to *Quercus robur* by 20% (top height at the reference age) and 40% (total volume production). Unfortunately, sufficient data was not available for a yield comparison of the other introduced tree species.

Conclusions

The study confirms the superior yield performance of *Abies grandis*, *Pseudotsuge menziesii* and *Quercus rubra*, which has already been stated by other authors (i.e. Spellmann 1993). Due to their impressive growth potential, these tree species are generally acknowledged as possible growing alternatives (Vor et al. 2015). It is difficult to predict how this assessment may develop under the ongoing trend in climate change, especially when one considers that the estimation of the viability of a tree species can also change under current environmental conditions. Without doubt, the growth potential of *Abies grandis* is impressive, but there are hints that this species is considerably exposed to risks due to droughts and fungi (Liesebach & Weißenbacher 2007, Huber et al. 2012).

Moreover, this study demonstrates that experiments that are scientifically worthwhile require much time, space and, finally, money. It might be disappointing that only 15 of the 40 introduced tree species could be evaluated in a statistically sound manner since the data base contained useful data from only a few tree species. As Huber (2012) or Kölling & Schmidt (2013) have already noted this underlines the big challenge for implementing and documenting long term experiments with its attendant high risk of failure. In the long-term nature of forestry production, there is the danger of assessing the characteristics and suitability of a specific tree species without knowing how to assess failures on the basis of surviving stocks so as to derive a general validity from individual case studies. In order to avoid such mistakes, growth and yield trials have to be designed thoroughly, which is not an easy task with regard to the diversity of forest growth conditions. This problem might be even greater for experiments that are focused on the suitability of tree species in the face of changing climate conditions. Using tree species, of which solid knowledge is available from their country of origin, is therefore advisable in this context (Taeger & Kölling 2016).

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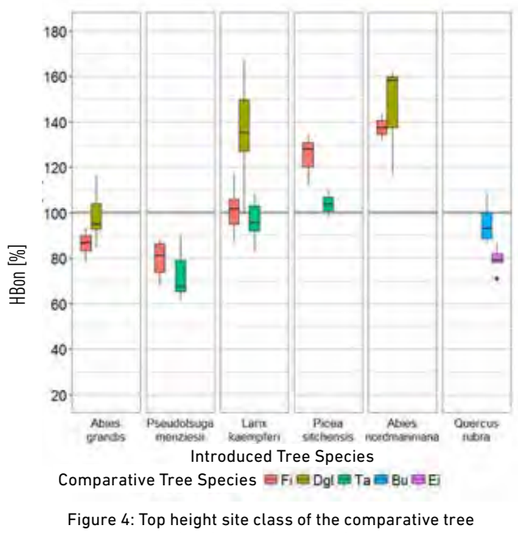

Figure 4: Top height site class of the comparative tree species in relation to the introduced tree species

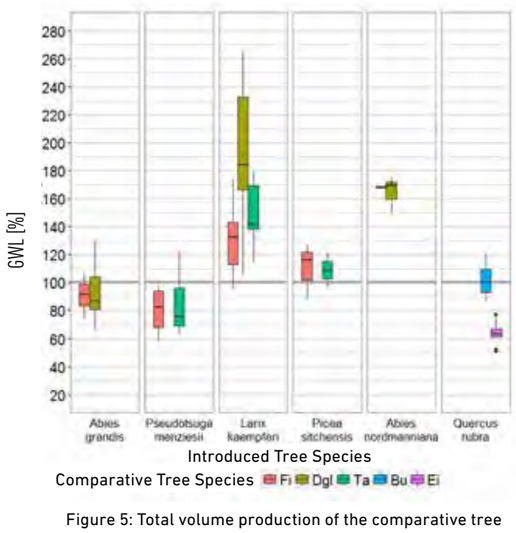

Figure 5: Total volume production of the comparative tree species in relation to the introduced tree species

THE BARK OF NORWAY SPRUCE AND SILVER FIR – Thinner than Expected

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Bark thickness is a critical measurement for assessing economic value of roundwood and for estimating wood and bark biomass. Tree and log diameters are usually measured outside bark, but inside-bark diameters are of greater economic interest and are often derived using local or regional species-specific bark thickness equations. The currently applied bark deduction values in Germany are based on measurements taken by the FVA in Baden-Württemberg in the 1970s. The objectives of this study were to review the currently used bark deduction values of Norway spruce (*Picea abies* (L.) Karst) and Silver fir (*Abies alba Mill*) using new measurements and to test their suitability for different bucking patterns and stem segments.

Table 1. Bark deduction values for log mid diameters with bark of Norway spruce and Silver fir based on old and new measurements.

		mid diameter	
	diameter deduction	old measurements (1970s) (HKS BW, RVR)	new measurements (2010s)
Norway spruce	1 cm	up to 26 cm	up to 31 cm
	2 cm	27 to 50 cm	32 to 51 cm
	3 cm	from 51 cm	from 52 cm
Silver fir	1 cm	up to 22 cm	up to 24 cm
	2 cm	23 to 38 cm	25 to 42 cm
	3 cm	39 to 55 cm	43 to 60
	4 cm	from 56 cm	from 61 cm

Measurements throughout the State of Baden-Württemberg

This study reassessed bark thickness data from the 1970s together with measurements made on hundreds of newly selected trees in dozens of forest stands throughout Baden-Württemberg. Pure spruce stands as well as mixed-species stands of conifers and hardwoods were chosen. In order to sample a wide range of diameter classes, trees from both thinning operations and final harvesting operations in selection cutting systems were chosen. The new measurements were made on 508 spruces and 217 firs that averaged 39.8 cm dbh and 48.3 cm dbh, respectively. Sample size was determined based on an analysis of bark thickness variability in the data from the 1970s. Regional variation of bark thickness within the state of Baden-Württemberg was accounted for by the geographical distribution of the experimental plots. Sample trees were felled, delimbed, and measured in the forest before any further log manipulation was performed. Measurement locations were at breast height (1.3 m above ground) and along the tree bole at two meter increments up to a top diameter of approximately 10-15 cm. Diameter and bark thickness were measured twice (approximately perpendicularly) at each location using both a calliper and a Swedish bark gauge, respectively.

photo U.H. Sauter

1

photo S. Stängle

2

photo S. Stängle

3

photo S. Stängle

4

1: Measuring bark thickness on a spruce log

2: Producing samples to determine tree age

3: Preparing a spruce log to validate automated bark detection algorithms using X-ray computed tomography

4: Sample preparation: Fridolin Sauter

Faster Growth Leads to Thinner Bark

Results show that the measurement position within a tree plays only a minor role for the simulated bucking schemes: long logs of 21 m length and stem sections of 5 m length. Thus, the same bark thickness function could be applied both for manual measurements and harvester head measurements. Bark thickness of recently measured trees at the same stem diameter is smaller compared to bark thickness 40 years ago, which leads to a shift of the class boundaries for bark deduction values (Table 1). Assuming a similar harvesting intensity and similar assortments as in the last five years, applying the new class boundaries would mean an increase in sales volume of manually measured spruce and fir logs by 1.5% and 0.9%, respectively, for the state of Baden-Württemberg.

In our study, we did not find convincing evidence for environmentally driven large scale spatial variation of bark thickness within the state of Baden-Württemberg. Age, however, was found to have a significant effect on bark thickness variation of both studied species, with increasing relative bark thickness for older tree ages. The observed effect of tree age leads us to conclude that increased growth rates affect allocation patterns thereby leading to an altered relationship between bark and wood increment. As the variation of growth rate is influenced largely by site and stand conditions, it seems that better site quality leads to a smaller relative bark thickness. In order to rule out methodological reasons for the smaller observed bark thickness of the recently measured trees, we measured trees using a method similar to that used in the 1970s. By simulating different bucking and sorting rules we ensured that log length was not causing the observed differences in bark thickness at log mid diameter.

Outlook

The findings of this study highlight the need to consider bark thickness variability when developing bark thickness equations and to regularly review existing bark thickness equations for their validity. The study focused on Norway spruce and Silver fir and clearly showed the need to update bark thickness equations for both species. Consequently, bark thickness equations for other species that are currently applied in Germany, which also had been developed in the 1970s, should also be reassessed. Douglas fir (*Pseudotsuga menziesii* (Mirb.) Franco) seems to be an especially important species because when the currently used bark deduction values were developed only Douglas fir logs smaller than today were on the market. The currently used bark thickness equations might, therefore, not accurately describe the actual bark thickness of logs traded now.

25 YEARS CONVENTWALD ECOSYSTEM STUDY

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Research Objectives

The Conventwald ecosystem study is a long-term project of the Department of Soil and Environment, which was initiated in 1991, and has delivered 25 years of continuous observation about water and element cycles (Puhlmann and von Wilpert 2009). The goal of the Conventwald study is to answer the questions, whether and to what degree different types of silvicultural management are able to counteract disturbances of ecosystems caused by deposition. The study examines how different silvicultural practices can protect the long-term stability of a site regarding plant available nutrient reserves, as well as surface and groundwater quality.

Monitoring Program

The Conventwald is one of five sites in Baden-Württemberg belonging to the ICP-Forest network, on which comprehensive measurements about the climate, soil water budget, element fluxes (input through precipitation, output through soil water seepage), the chemical status of the soil, the soil gas budget, as well as forest stand nutrition, growth and vitality are carried out based on standards that are uniform throughout Europe.

The area under investigation comprises a near-natural mixed beech, fir and spruce forest (protected forest), as well as different silviculturally managed areas bordering it. On the one hand, the measurement areas are in closed forest stands, where subareas were created in crown centers, the crown edges and the gaps between crowns. On the other hand, different larger, naturally occurring gaps in the forest stand, several gaps from selective patch logging, as well as a clear-cut were utilized to observe their immediate effects on element fluxes in the soil zone. At the outlet of the catchment area – as an integral measure for the dynamics of the different forest stand structures – the amount and chemical composition of the runoff are being monitored.

The long-term, almost uninterrupted observations of the Conventwald ecosystem study make it possible to see long-term trends, e.g. in climatic conditions and in element input and output, as well as short- and medium-term reactions of the forest ecosystem to disturbances such as logging activities and droughts. A selection of results from the ecosystem study is presented in the following sections.

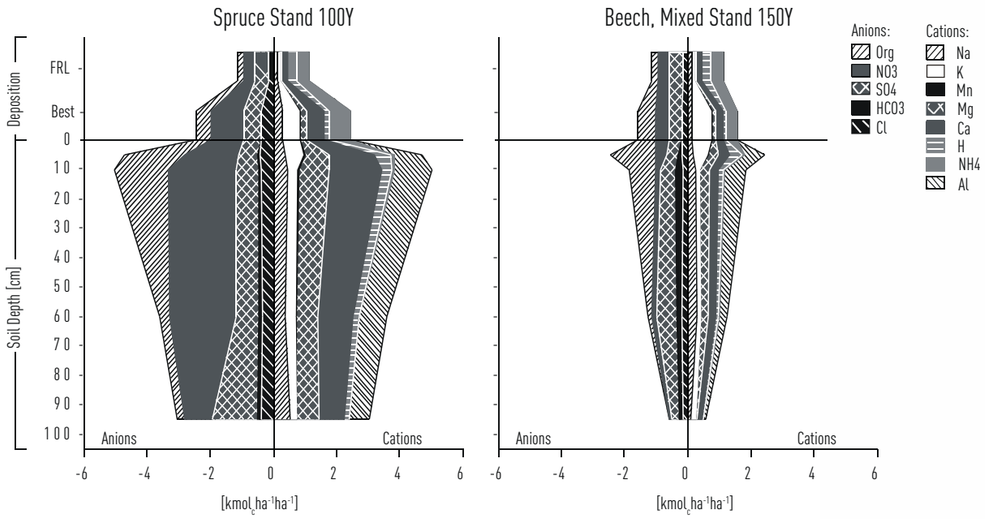

Figure 1: Ion fluxes along the flow path from precipitation on open land (FRL), to precipitation in the forest stand (Best.), and through the soil up to a soil depth of 100 cm for a spruce stand and a mixed beech stand. Average values for the hydrological years 1995 to 2002.

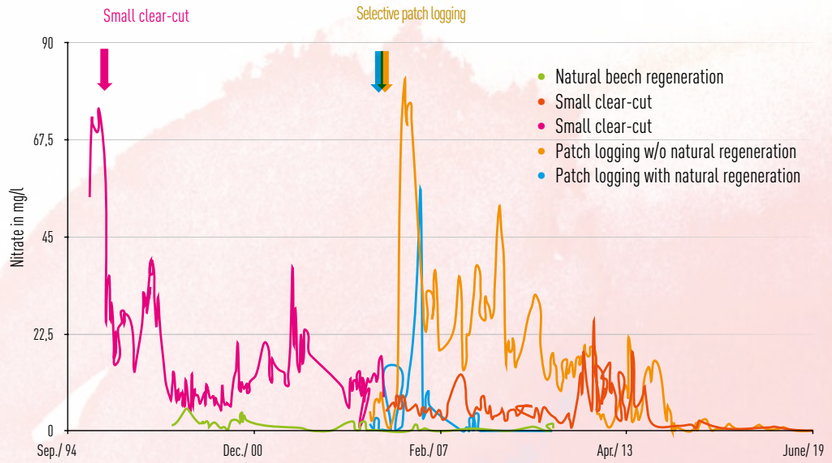

Figure 2: Nitrate concentrations in the seepage water below the root space (120 cm soil depth) in natural regeneration of beech (green), a small clear-cut (red), as well as two gaps from selective patch logging with (blue) and without (orange) natural regeneration.

High Element Output of Spruce Stands

The different forest stands vary significantly in both the element input through precipitation and the output through soil seepage water. A comparison between ion fluxes of a 150-year old mixed beech/fir/spruce stand and a 100-year old spruce stand shows the potential in choosing tree species for preserving closed element cycles (fig. 1). The biggest difference between the two forest stands is found in nitrate fluxes. These are negligible in the mixed beech stand while they dominate the element budget of the spruce stand. Also, high sulfate fluxes below 60 cm soil depth boost the output of base cations in the spruce stand. These fluxes originate from the remobilization of precipitated sulfur from earlier depositions. In the mixed beech stand, the element flux density beneath the root zone is lower than the input through precipitation which causes soil nutrient reserves to remain largely intact. This example shows that the choice of tree species can make a noteworthy contribution to preserving the soils' role of providing nutrition, as well as other functions of the ecosystem such as acidity buffering and nitrogen storage.

High Nitrate Output after Timber Harvesting

As an example, figure 2 shows long-term nitrate measurements of the soil water in a small clear-cut, in two selective patch logging areas, and in an area of developing natural beech regeneration. Interestingly figure 2 shows how nitrate concentrations increase abruptly after logging activities. The selective patch loggings generated nitrate peaks in the soil seepage water like those of the small clear-cut, but had a significantly smaller impact on the nitrate load in the runoff due to their smaller surface area. The effect of the developing natural regeneration is striking. In the patch, where vital natural regeneration was already present at the time of logging, nitrate concentrations decreased to the initial level within a few years after logging, while in the patch without natural regeneration, increased nitrate concentrations were observed up to 10 years after logging.

Balanced Element Budget in Continuous Cover Forest

From the individual measurements, cumulative element balances of base cations were derived for total silvicultural rotation times (von Wilpert 2008). Fifty element budgets representing different forest stand phases were available in the area under investigation. They were combined for different silvicultural treatment strategies. The element budgets are the result of element input through deposition and rock weathering on the one hand, and element output through seepage water and timber harvesting on the other. Figure 3 shows the progression of the base cation budgets (Ca, Mg, Na and K) through complete rotation times for different silvicultural procedures that deviate substantially from one

another regarding the element budget. The two procedures involving clear-cuts show a net loss in base cations of 5-6 kmolcha-1a-1 during the clear-cutting phase. Twenty-five years after clear-cutting the beech stand, the base cation budgets were balanced again. For the spruce stand, in contrast, a loss of base cations can be seen throughout the entire rotation time. The beech/fir/spruce continuous cover forest proves to be the most conservative treatment strategy that does not show longer periods of extensive base cation losses.

Summary & Prospects

Element flux measurements are suitable tools for understanding changes that are motivated by deposition of acids and nitrogen in ecosystems. The objective of the Conventwald Study is to identify the possibilities that forest management has in terms of controlling sustainability under the given environmental conditions. We showed that silvicultural treatment strategies can make a valuable contribution to preserving site quality. Gap-oriented harvesting practices showed balanced nutrient budgets in the Conventwald. In contrast to that, less gentle silvicultural practices such as pure spruce stands with clear-cut regeneration lead to high base loss on the same site. Also, the choice of tree species has an important potential to counteract soil acidification. In the Conventwald, beech stands tend to show positive base cation budgets, while they are clearly negative for the spruce stands.

The results demonstrate that ecosystem studies such as the Conventwald Study or the ICP-Forest program are important tools for monitoring site quality and sustainability. They also make it possible to assess the value of forest ecosystems to provide ecosystem services such as drinking water security. Future objectives of the Conventwald Study will focus on the reactions of the forest ecosystem to climate change, and the threat to site sustainability because of a continuingly high nitrogen input.

Literature
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Wilpert, K. v.(2008): Waldbauliche Steuerungsmöglichkeiten des Stoffhaushalts von Waldökosystemen am Beispiel von Buchen- und Fichtenvarianten der Conventwald-Fallstudie. Schriftenreihe Freiburger Forstliche Forschung, Band 40, 275 S.

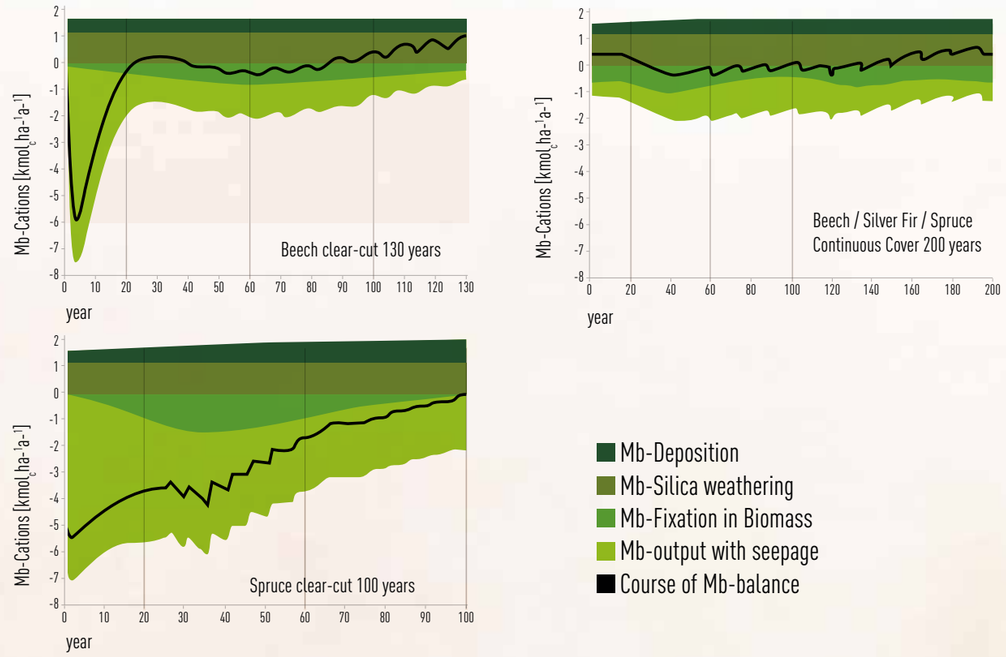


Figure 3: Progression of the annual base cation budget (Ca, Mg, Na and K) of a pure beech stand after a clear-cut (top left), a spruce stand with a clear-cut (bottom left), and a mixed beech-fir-spruce forest in continuous cover management.

ORGANIZATION of the FVA

ADVISORY BOARD

DIRECTORATE | DIRECTOR
Prof. Konstantin v. Teuffel
- Administration and Management
- Central Technical Services and 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 Breeding[1]
- Forest Plant Genetics[1]

[1] in 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
- Accontancy 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 Engeneering
- 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 spectrum of tasks; these departments are coordinated and managed by the Directorate (see organization chart). As regards to content and strategic issues the FVA is advised by an Advisory Board. The Advisory Board's tasks and responsibilities include among other priorities evaluating the overall development and direction of the FVA, as well as formulating recommendations for strategic alignment, priorities for future research work and the 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-University 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 attended 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.

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 und Konstantin v. Teuffel

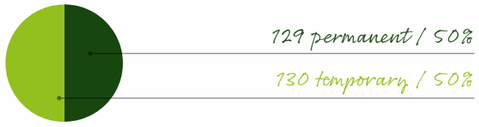
Employee Numbers slightly Decreased

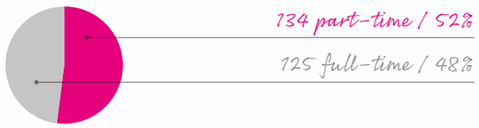
At the end of 2016, 259 persons were employed by FVA – 47 percent (121) female and 53 percent (138) male. Compared to the previous year, the number of employees decreased by 14 persons the gender ratio remaining the same. Forty-eight percent of all employees worked full-time while 52 percent were part-time. 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 58 percent. Half of the employees had a permanent employment contract at the end of 2016, which represents an increase of nine percent compared to the previous year.

Eight percent of employees had other than a German nationality. They came from the following countries: Australia, Brazil, Bulgaria, China, Colombia, Finland, France, Greece, Italy, Latvia, the Netherlands, Poland, Romania, Spain, Switzerland and Venezuela.

Total number of employees end 2016:

259





Two new Departmental Heads

On April 14th, in the context of a FVA farewell seminar Associate Professor Dr. Klaus von Wilpert took leave for his retirement. He had worked for the FVA for a total of 26 years; 19 years of which as Head of the Soil and Environment Department. His successor as of July 1st is **Dr. Heike Puhlmann**. She has been working for the department since 2010. She is the first female department head within the FVA.

Totally new in the house, however, is **Dr. Jörg Kleinschmit** who changed from the North-West German Forest Research Institute to take on the leadership of the Forest Nature Conservation Department beginning on October 1st, 2016. He succeeds Dr. Eberhard Aldinger, who retired at the end of September 2015.

Ulrich Schraml on the Sustainability Council

On October 26th, 2016, German Chancellor Angela Merkel appointed Professor **Dr. Ulrich Schraml**, Head of the Forests and Society Department, as one of 15 members of the German Council for Sustainable Development. The term of office for this position is three years – beginning November 1st, 2016. Since 2001, the German Council for Sustainable Development advises the German government regarding the implementation and further development of the German sustainability strategy.

Recent Doctorates

The following FVA scientists completed their doctoral thesis 2016:

Robert Hagen (Forests and Society Department) on the topic "Factors affecting the population dynamic of roe deer (Capreolus capreolus): The impact of climate variations, hunting and predation"

Vukan Lavadinovic (Guest scientist from Serbia, working in the Forests and Society Department) on the topic "Analysis of the hunting sector in Republic of Serbia"

Carina Sucker (Soil and Environment Department) on the topic „Statistische Indikatoren der Gewässerversauerung – Trend, standörtliche und forstwirtschaftliche Einflüsse" ("Statistical Indicators of Water Acidification – Trends, Stand and Forestry Influences")

Maria-Barbara Winter (Forest Nature Conservation Department) on the topic „Natürliche Waldentwicklung unter dem Einfluss des Borkenkäfers im Nationalpark Berchtesgaden – Bestandesstruktur und Biodiversität im Verlauf von Störung und Sukzession" ("Natural Forest Development under the Influence of Bark Beetles in National Park Berchtesgaden – Stand Structure and Biodiversity in the course of Disruption and Succession"

Big Birthdays

Three former department heads celebrated a major birthday 2016:

Dr. Erwin König, former Head of the Forest Health Department turned 90 on April 6th.

Dr. Joachim Hradetzky, former Head of the Biometry and Computer Science Department turned 80 on September 21st.

Dr. Helmut Volk, former Head of the Landscape Management Department (now Forests and Society) turned 75 on November 11th.

The FVA congratulates them on their milestone birthdays.

photo Christian Haas photodesign

'Family-friendly Enterprise' distinction handed to Joachim Kermann, FVA administration manager

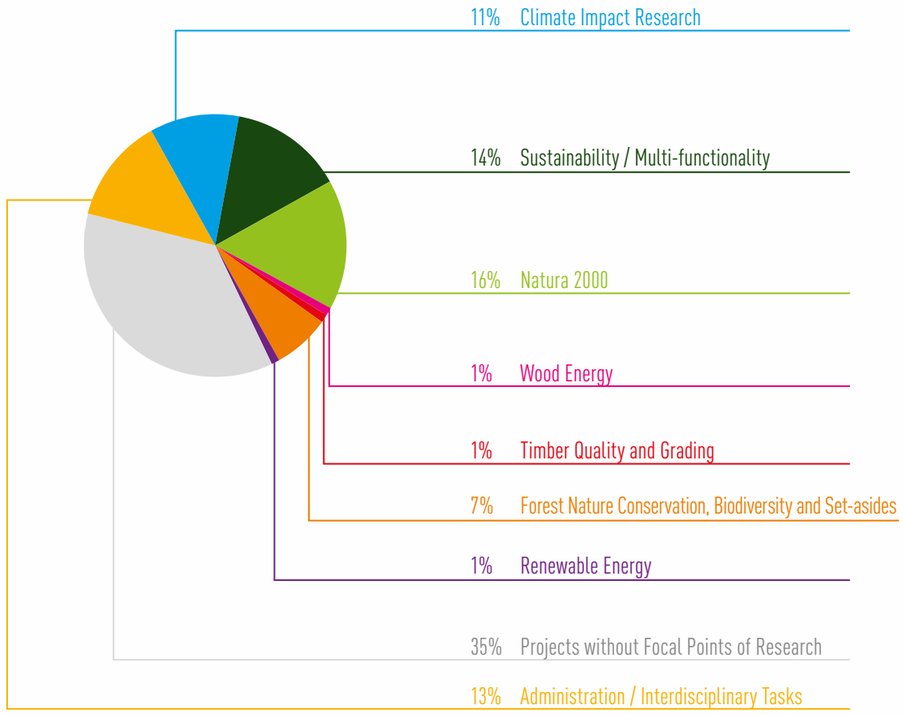
Recognized as Family-Friendly

The FVA is very pleased to receive the label 'Family-friendly Enterprise' with which it was rewarded on November 22nd by the Ministry of Economic Affairs, Labour and Housing of Baden-Württemberg, the Employers Baden-Württemberg and the Council for Family Affairs Baden-Württemberg, in the framework of the familyNET project. For this designation, the following were reviewed: organisational activities in the field of management competency, personnel development, working place, time and organisation, communication, monetary benefits, family and health services and civic involvement. The FVA scored especially due to flexible working hours, teleworking possibilities, operating its own day-care facility for children, offerings for nursing relatives and activities regarding organisational health management.

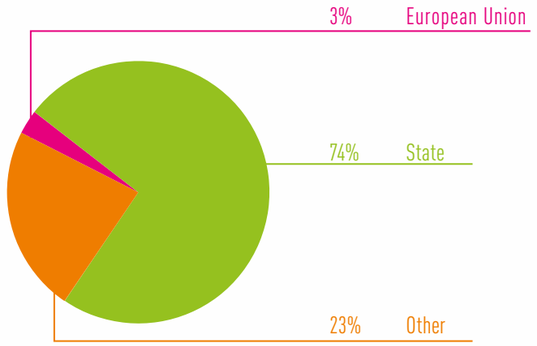
More Federal Funding

In 2016, the total FVA budget amounted to approximately 14.5 million euros. Eighty-seven percent of this amount was allocated to the research budget and 13 percent to administration and cross-sector tasks. Personnel expenses amounted to nearly 9 million euros (62 percent) compared to 5.5 million euros (38 percent) for supplies, equipment and other operating costs. With almost 2.1 million euros, the proportion of third-party funds made up 14 percent of the total budget, which is slightly less than the year before (almost 2.4 million euros). Compared to the previous year, EU funding has clearly decreased, while Federal funding has increased accordingly: In 2016, the EU made up a slim three percent of third-party funding (2015: 13 percent), the federation 74 percent (2015: 61 percent) and other sources 23 percent (2015: 26 percent).

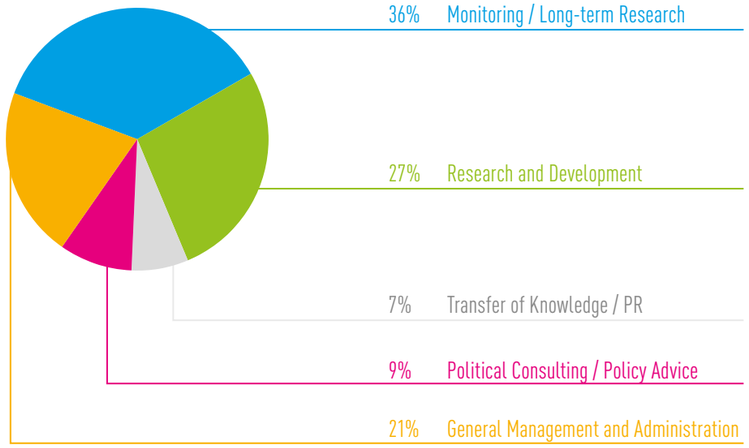
Resources According to Focal Points of Research (14.484.612 €)



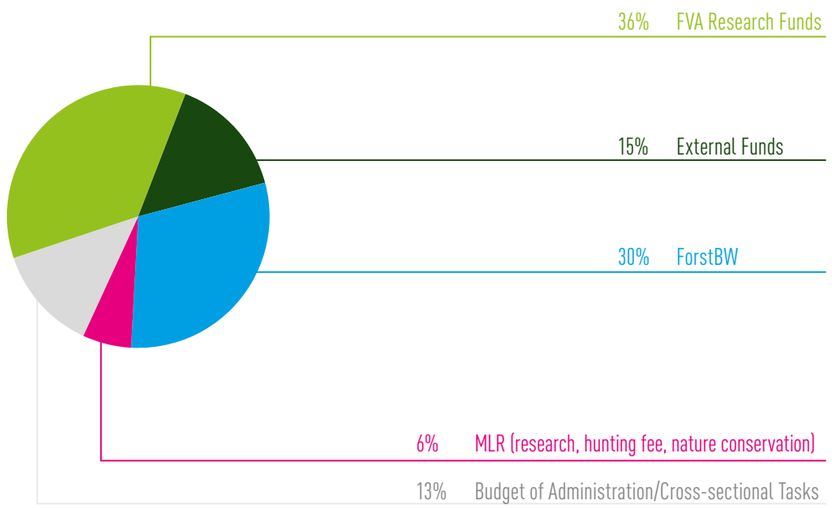
Origin of External Funds (2.139.558 €)



Resources Based on Competency (14.484.612 €)



Resources Based on the Origin of Funds (14.484.612 €)



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