

# **Questionnaire**

## **Summary of the main activities of a research institute of the Slovak Academy of Sciences**

*Period: January 1, 2016 - December 31, 2021*

### **1. Basic information on the institute:**

#### **1.1. Legal name and address**

Institute of Forest Ecology, Slovak Academy of Sciences, L. Štúra 2, 960 01 Zvolen, Slovakia

#### **1.2. URL of the institute web site**

<https://www.ife.sk>

#### **1.3. Executive body of the institute and its composition**

<b>Directoriat</b>	<b>Name</b>	<b>Year of birth</b>	<b>Years in the position, from - to</b>
<b>Director</b>	Ing. Jozef Válka, CSc.	1952	01/2016 – 05/2016
<b>Director</b>	RNDr. Ľubica Ditmarová, PhD.	1963	06/2016 – 12/2021
<b>Deputy director</b>	RNDr. Ľubica Ditmarová, PhD.	1963	01/2016 – 05/2016
<b>Deputy director</b>	Ing. Miroslav Blaženec, PhD.	1974	06/2016 – 12/2021
<b>Scientific secretary</b>	Mgr. Peter Kaňuch, PhD.	1977	06/2016 – 05/2017
<b>Scientific secretary</b>	Mgr. Katarína Pastirčáková, PhD.	1976	06/2017 – 12/2021

#### **1.4. Head of the Scientific Board**

RNDr. Ján Kulfan, CSc. - 01/2016 - 03/2017

RNDr. Anton Krištín, DrSc. - 03/2017 - 03/2021

Ing. Gabriela Jamnická, PhD. - 03/2021 – 12/2021

##### **1.4.1 Composition of the International Advisory Board**

An International Advisory Board of the Institute of Forest Ecology, Slovak Academy of Sciences (IFE SAS) hereinafter termed „the Board“, is hereby established to ensure independent international assessment of the scientific quality of the research output of the IFE SAS in an effort to have European and global impact in the field ecology and forest ecology sciences. The Statute of the Board was approved by the Scientific Board of the IFE SAS on 4 March 2020.

The Board brings the knowledge and experience to advise IFE SAS on the planning and implementation of the Research strategy for defined time period and complementary Action plan. The Board is expected to:

- formulate recommendations and advices on research performance, organisation of the IFE SAS and personnel structure, so as the results are visible at the European level and valuably contribute to the given research fields in Europe, and IFE SAS belongs to outstanding performers;
- give feedback on scientific career management;
- make recommendations on co-operation with competent international scientific institutions and universities;
- make recommendations on raising funds, allocating them to project and extra support for successful research teams and individuals.

The Board is composed of up to four external members who are outstanding senior researchers, key representatives of research fields cultivated at IFE SAS with strong international reputation. The membership period in the Board is for 5 years.

Members of the Board:

- **prof. RNDr. Ing. Michal V. Marek, DrSc., dr. h. c.**  
Global Change Research Institute CAS (CzechGlobe), Brno, Czech Republic
- **Dr. Herbert Hoi**  
Konrad Lorenz Institute of Ethology, University of Veterinarian Medicine Vienna, Austria
- **Prof. Dr. Paolo Cherubini**  
Swiss Federal Research Institute WSL – Birmensdorf, Switzerland
- **Prof. Dr. Fredrik Schlyter**  
Swedish University of Agricultural Sciences, Alnarp, Sweden

In accordance of the Statute of the Board, IFE SAS organized Board meeting in October 2021, where we presented our research and development activities during period 2016-2020.

The Board prepared an Evaluation Report based on a study of the available materials and an extensive discussion with the institute's management and research team leaders. As part of its report, the Board stated that significant progress had been made in the quality and productivity of the institute's scientific work, in the organizational area and in terms of the social impact of the institute's activities compared to the last accreditation in 2016. The Board recommended to the Institute of Forest Ecology to increase the horizontal cooperation of departments, research teams, e.g. linking in a newly-designed project. Regarding the organizational structure of the institute, the Board proposed grouping some departments into larger units on a single thematic platform - in line with the Institute's Strategy.

## 1.5. Basic information on the research personnel

### 1.5.1. Fulltime equivalent work capacity of all employees (FTE all), FTE of employees with university degrees engaged in research projects (FTE researchers)

2016		2017		2018		2019		2020		2021		2016-2021	
FTE all	FTE researchers	FTE all	FTE researchers	FTE all	FTE researchers	FTE all	FTE researchers	FTE all	FTE researchers	FTE all	FTE researchers	average FTE all per year	average FTE researchers per year
104.31	58.04	104.87	63.94	102.93	46.88	105.18	46.67	103.25	45.43	99.71	41.19	103.38	50.36

**1.5.2. If applicable, add also a short information on the merger of the institute in the evaluation period. You can also add rows in the above table corresponding to the founding institutes**

N/A

**1.6. Basic information on the funding of the institute**

**1.6.1. Institutional salary budget, other salary budget<sup>1</sup>, non-salary budget<sup>2</sup>**

<b>Salary budget</b>	<b>2016</b>	<b>2017</b>	<b>2018</b>	<b>2019</b>	<b>2020</b>	<b>2021</b>	<b>average</b>
<b>Institutional salary budget</b> <i>[millions of EUR]</i>	1.156	1.243	1.322	1.591	1.687	1.685	<b>1.447</b>
<b>Other salary budget</b> <i>[millions of EUR]</i>	0.164	0.225	0.262	0.176	0.206	0.190	<b>0.204</b>
<b>Total salary budget</b> <i>[millions of EUR]</i>	1.320	1.468	1.584	1.767	1.893	1.875	<b>1.651</b>
<b>Non-salary budget</b> <i>[millions of EUR]</i>	0.699	0.720	0.757	0.708	0.830	0.640	<b>0.726</b>

**1.7. Mission Statement of the Institute as presented in the Foundation Charter indicating the years when it was adopted and revised**

The Institute of Forest Ecology of the Slovak Academy of Sciences (SAS) was established by the decision No. 689/1 of the Presidium SAS dated 17 June 1987. Since 1 July 1990 it has been operating as an independent economic unit; as a contributory organisation since 1 January 1993. The headquarters of the institute are situated in Zvolen. The other satellite workplaces are located in Nitra (Department of Plant Pathology and Mycology), Bratislava (Department of Strategic Environmental Analyses) and Mlyňany (the Arboretum).

The most recent enlargement of the institute facilities represent a detached branch in Bratislava (since 1 November 2012, the Department of Strategic Environmental Analyses formerly belonging to the Prognostic Institute of the SAS and since 1 December 2013, the Laboratory of Molecular Apidology formerly belonging to the Institute of Molecular Biology SAS). Following the decision No. 242C of the Presidium SAS dated 3 April 2014, the specialised organisation of SAS – Arboretum Mlyňany was merged with the Institute of Forest Ecology SAS since 1 July 2014, while the original name of the workplace “Arboretum Mlyňany” was retained. Following the decision No. 1204C of the Presidium SAS dated on 11<sup>th</sup> March 2021, the Laboratory of Molecular Apidology has been delimited to the Centre of Biosciences SAS since 1<sup>th</sup> April 2021.

According to the Foundation Charter No 305/G/12/20147 signed on 20 June 2014, the institute focuses on the basic and applied research in forest ecology. Institute's research programme features the research on changes, processes and stressors important for the stability, structure, production and protection of forest ecosystems. The research focuses on close-to-nature and human-influenced ecosystems, their dynamics, components, regimes, elements and relationships, leading to conclusions that can be applied in several scientific fields and research branches, mainly in forest silviculture and protection, and strategic management of biodiversity. The impact of abiotic and biotic natural stressors, anthropogenic load and interventions on the health status of forest tree species and the stability of forest ecosystems is studied comprehensively. The study of native as well as introduced tree species and their stands is among research priorities of the institute. A special

<sup>1</sup> Salary budget originating outside the regular budgetary resources of the organization, e.g. from the project funding.

<sup>2</sup> Includes Goods and Services and PhD fellowships

emphasis is put on biology, ecology, management and protection of tree species and their fungal and animal associates, in both forest and urban environments, human settlements included.

The institute has been gaining original knowledge in the field of forest ecology in the home country and abroad. It has been providing advisory and expert services on forest ecology to state and private institutions. In the form of postgraduate studies it has been providing education in the area of ecology, biodiversity protection and related research areas.

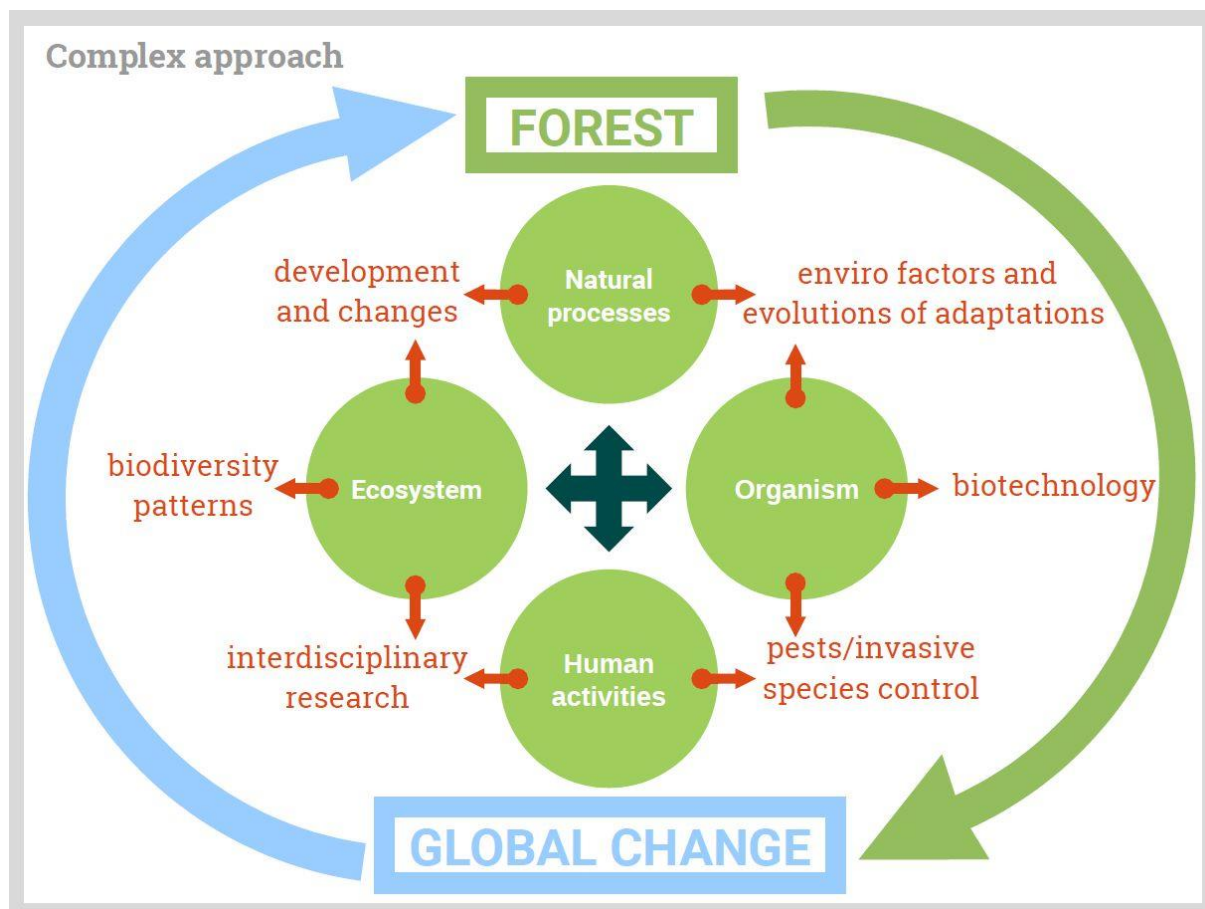
The institute collects, registers and presents global and national gene pools of woody plants. It organises their collections according to the scientific rules for organisation and presentation of woody plants. Under in-situ conditions it gathers and protects endangered autochthonous woody plants of Slovakia facing extinction. Apart from the semper vireo character of the natural collections, the presentation of the gene pools is performed also on the base of the ecological and geographic principles.

The institute works out the master plans of greenery and projects of green landscaping, designs of greenery and undertakes their development, designs of terrestrial systems of ecological stability, valuation and assessment of the health status of the greenery. From the production activities the institute grows bare-root plant material, reproduces ornamental plants by micropropagation of tissue cultures, and supplies and plants grown woody plants within landscape design activities.

### Additional information

2016 - 2021 – a new period in the development of the institute based on strategic planning, regular updating of the IFE SAS Action Plan and application of the principles of open communication.

Our mission:



On 5 October 2021, the Act No. 347/2021 Coll.; came into force, which amended and supplemented the Academy Act and the Geology Act; based upon the Section 21aa(1) of the Academy Act as amended upon the Act No. 347/2021 Coll., the organisations of the SAS will change their legal form into public research institutions on 1 January 2022. Following the Section 21aa(1) of the Academy Act and on the basis of the [Foundation Charter](#), the legal status of the Institute of Forest Ecology SAS will be transformed from a state contributory organisation into a public research institution.

**1.8. Summary of R&D activity pursued by the institute during the evaluation period in both national and international contexts. Describe the scientific importance and societal impact of each important result/discovery. Explain on general level – the information should be understandable for a non-specialist (recommended 5 pages, max. 10 pages for larger institutes with more than 50 average FTE researchers per year as per Table 1.5.1.)**

The main principles of long-term development of the Institute of Forest Ecology (IFE) of the Slovak Academy of Sciences (SAS) are elaborated in two documents: „*Research development strategy of the Institute of Forest Ecology of the Slovak Academy of Sciences for the period 2018–2023*“ and „*Action plan for research development of the Institute of Forest Ecology of the Slovak Academy of Sciences for the period 2018–2023*“. We developed these theses in connection with the conclusions of the international evaluation panel, which assessed the results of the workplace for the period 2012-2015.

Our idea was to more intensively link the focus of the institute with the strategic directions of research, especially within the European research area. These are mainly the following directions:

- Research into the impacts of global changes on forest ecosystems and related societal aspects
- Biodiversity, dynamics and evolution of forest ecosystems
- Ecology of woody plants and forest ecosystems
- Protection and enhancement of the rare and rich gene pool of the Mlyňany Arboretum IFE SAS in close connection with related research activities

Based on the currently available scientific capacities and infrastructure at the IFE SAS, we have set in this context two key strategic research priorities for the period 2018–2023:

1. Adaptation mechanisms of forest ecosystems to changing climate conditions
2. Disturbances in forest ecosystems

1. In relation to research priority “**Adaptation mechanisms of forest ecosystems to changing climate conditions**” we would like to highlight our following R&D activities:

**The dynamics of forest ecosystems processes in relation to recent environmental changes**

At present, the impact of global environmental changes on the environment, including forest environments, is very topical. In this context, it is important to know the relationships between the living and non-living components. Our department has long been engaged in such research, focusing on the dynamics of the processes running within forest ecosystems which are affected by anthropogenic activities of varying intensity. Attention is paid to spatio-temporal changes in individual levels of the forest, such as soil, herbs and trees of the ground layer, tree layer and finally the atmosphere. The quality of our scientific work was shifted over the last years in terms of methodology and expertise. We use high-quality computer software for statistical processing of results (programs R or Statistica ®) as well as for modeling processes in the forest environment (e.g. Sibyla and Anafore). These skills we have implemented in the frame of the national (VEGA) and international (ERDF, iSBio, MAD) research projects.

Our research is focused mainly on the study of the soil-plant or mycobiota-forest relationships as well as surviving of the natural regeneration of woods. At the same time we study the response of plants on ongoing environmental changes through their phenological activity, which is considered

the important bioindicator of the changes. We also pay attention to analysis of long-term atmospheric deposition of the toxic elements (acidification components, ground-level ozone) affected the health of the plants. Despite of the significant decrease of the industrial pollution we have found that the environmental contamination of forest ecosystems by atmospheric immissions from anthropogenic sources and subsequent [plant intoxication](#) are evident. We observed the damage of plant assimilation organs and also the acidification of upper layers of the soils. In the case of research on [mycocenoses dynamics](#) in forest reserves and commercial forests, significantly species-richer mycobiota was found in both protected and primeval forest stands compared to species-poorer mycobiota in the commercial or monoculture forests, whereas rare fungi were often occurred only in primeval forests. The negative [impact of fluorine immissions on the beech stand](#) in the wider vicinity of the aluminum plant in Žiar nad Hronom, which is one of the most contaminated regions in Slovakia, is monitored for a long time. However, preliminary results of ongoing research at this site give hope that environmental conditions are improving here as well, and the natural regeneration is beginning to revitalize. [Long-term phenological observations](#) on the beech have confirmed the influence of rising air temperature on the onset of both spring and autumn phenological phases. The trend analysis showed the extension of the growing season of the beech for more than two weeks. Attention is also paid to the study on one of the toxic atmospheric components – ground-level ozone. The impact of the parent stand on ozone concentration values does not seem to be negligible. This is confirmed by the results of multi-year measurements of [ground-level ozone concentration](#) in the beech ecosystem during the growing season. These brought quite surprising results - the concentration values in the interior of the adult stand were always higher compared to the environment without the tree component. In this regard we are getting started this research also in urban environment to better understand the causes of this phenomenon.

Based on the obtained long-term results, we can compare the previous state with the current one, which will create the preconditions for creating a proposal to optimize the intensity of anthropogenic interventions in the studied forest ecosystems as well as in screening potential plant accumulators and proposing corrective measures. Our findings can be useful also for environmental management in both rural and forest ecosystems. At the same time they can help in actual designing and formulating of the adaptation and mitigation strategy as was emphasizes in the document of Ministry of Environment of the Slovak Republic “Adaptation Strategy of the Slovak Republic on Adverse Impacts of Climate Change”.

### **Damage in pine communities: hosts, pathogens and their reproduction, genetic diversity and population structure**

Dothistroma needle blight (DNB) is one of the most damaging and economically important foliage diseases of pine stands and plantation worldwide caused by two closely related ascomycetous fungi: *Dothistroma septosporum* and *D. pini*. Surveys and [reviews](#) forming part of the project (COST FP1102: Determining invasiveness and risk of *Dothistroma*, DIAROD) have shown [global distribution](#) and extensive host range however missing data from Slovakia. This lack of information and increasing incidence and severity of disease in the Northern Hemisphere initiated our interest in DNB research and health state and/or injury of pine stands.

Based on the molecular analysis (DNA extraction, PCR), the both phytopathogenic species, *D. septosporum* and *D. pini*, were detected causing damage of pines in Slovakia.

All pine species native to Slovakia (*Pinus cembra*, *P. mugo*, *P. sylvestris*) were identified as hosts for DNB. However, the positive findings for the native species *P. cembra* and *P. mugo* came from only artificially planted trees outside of their natural range. We recorded new [DNB host](#) species. Specifically, *D. pini* occurrence represent first records in Slovakia as well as in Europe and four of them are new host species of *D. pini* worldwide. In addition to pine hosts *D. pini* was also detected on *Picea abies*. This finding is a rarity, the first observation of *D. pini* on a non-pine host. Our results have expanded the known host range of this pathogen worldwide.

The results of mating types identification, genetic diversity and population structure of Slovak populations of both these pathogens suggest, that [D. septosporum](#), with high genetic diversity, high number of haplotypes and presence of both mating types is a long-established pathogen in Slovakia with asexual and sexual mode of reproduction, spread both naturally and artificially by human assistance. While the population of pathogen [D. pini](#) characteristic by high clonality, low gene and



genetic diversity, single mating type per site indicating asexual mode of reproduction is recently introduced pathogen in Slovakia. No other population studies, including determining the contribution of sexual recombination on the genetic diversity of *D. pini*, have been conducted, they lacking worldwide. Data regarding Slovak *D. septosporum* population were part of [global population study](#) that elucidated the historical migration pathways and the Eurasian origin of the fungus. Results also gave insight into the distribution, gene flow, extent of variability that are related to pathogen virulence, as well as evolutionary potential such as the ability to adapt to new changing environmental conditions and are useful for stands management and protection strategy. The obtained extensive dataset and results provide new challenges for further connected research we pursue recently: the pathogenicity of two DNB pathogens and their different haplotypes, determining their temperature tolerance and adaptation in relation to climatic change, shift of its climatic barrier.

Excessive [mortality of \*P. sylvestris\*](#) recorded in the Záhorská nížina lowland in western Slovakia, was assigned to continuous drought, bark beetles and blue-stain fungi. Two from blue-stain fungi, *Ophiostoma ips* and *O. minus*, which are new for the mycoflora of Slovakia, were identified as colonizers of the inner bark, phloem and blue-stained sapwood, and were observed in the galleries of *Orthotomicus longicollis*. These first results launch an idea for our recent research activities including diversity, pathogenicity and genetic variability of ophiostomatoid fungi, interactions between the fungi, Scolytid bark beetles and their hosts.

### **Benefits and troubles standing behind introduction of non-native woody plant species**

People worldwide have numerous experiences with noxious plants, which were formerly known as attractive ornamentals. Since many invasive plant species (black locust (*Robinia pseudoacacia*) among them) penetrate protected areas, where restricted management rules are in force, discussion on their nature-friendly regulation has been raised. In this respect, natural plant interactions, appearing near botanical gardens, can be a source of inspiration. Our research focussed on two situations observed in the Central-European space: black locust forests infested by escaping common hackberry (*Celtis occidentalis*) or black cherry (*Prunus serotina*) seedlings. As found in cooperation with Hungarian and Ukrainian colleagues, common hackberry can completely erase the invasive black locust. Its allelochemicals suppress black locust growth and nitrogen fixation and diminish its competitive ability. On the other hand, black cherry does not affect black locust performance at all. [Hence, extract from common hackberry leaves has potential in the black locust target elimination as a bio-herbicide](#). One of the worst invasive organisms in the world, tree-of-heaven (*Ailanthus altissima*), widely uses allelochemicals for establishment in new ranges. However, are there any woody plant species producing substances able to suppress this suppressor? To answer this question, we set up an experiment, in which tree-of-heaven seedlings were treated by leaf extracts from black walnut (*Juglans nigra*), common hackberry, false indigo bush (*Amorpha fruticosa*) and Chinese toon (*Cedrela sinensis*). [The largest suppressive effect to tree-of-heaven was provided by black walnut and, as showed by second trial, not only flavonoid juglone was responsible for it.](#)

Who would not know the beautiful flowering Magnolias, which adorn our parks in early spring. A total of 19 species/cultivars of magnolias, originating in different parts of the world are a part of the 130 years old Mlyňany Arboretum collections. In addition to their beauty, magnolias are known to be a source of numerous bioactive substances and extracts from their bark have been used for centuries in traditional Chinese and American medicine. The greatest attention has been paid to magnolol and honokiol - polyphenols, which were first determined in *Magnolia officinalis* and *Magnolia obovata*. In our research, concentrations of these substances in the arboretum collection as well as their distribution in the plant, were studied using gas chromatography with mass spectrometry (GC-MS). *Magnolia officinalis* strongly dominated both in magnolol and honokiol bark concentration and it was the only one species synthesizing them in leaves. However, how could be enough plant material for pharmaceutical industry ensured? Conventional methods did not work satisfying, when there is so large demand for plants, therefore tissue cultures in *in vitro* conditions (cultivation of plant parts on culture media in controlled environment) has to enter this play. Besides species/cultivar specificity, [Standardi & Catalano multiplication medium with addition of BAP cytokinin was found as optimal for most of the studied magnolia genotypes.](#)

Plant endophytes are microorganisms inhabiting living inner tissues of plants. They can have many positive impacts on their host plants. The diverse community of plant endophytic bacteria and fungi can help the host plant to increase its tolerance towards several abiotic and biotic stressors, such as drought, salinity, heavy metals, and microbial pathogens, but they act also as potent plant immunity and growth promoters. Studying plant endophytic microbes, their changes and dynamics over time and in response to different conditions is important for identification of novel strains which could be further developed into new generation of plant bio-fertilizers and bio-protectants. Metabolic activity of novel strains of endophytic bacteria and fungi can also provide novel source of pharmacologically active metabolites for medicine and biotechnologies. In our recent work [we isolated, identified and characterized over 250 isolates of endophytic bacteria from leaves of evergreen perennial cherry laurel \(\*Prunus laurocerasus\*\)](#) and described the dynamic changes of their community during the transition period from winter dormancy to vegetative growth.

### **Physiological changes in main Central-European tree species and their populations as responses to drought stress - from inter-species to intra-species research**

In terms of ongoing climate change, drought stress is evidenced to negatively influence a variety of essential physiological processes in trees, from basic processes such as: net CO<sub>2</sub> assimilation rate, photosystem PSII effectivity, chlorophyll a fluorescence, water use efficiency, stomatal conductance, through metabolism and growth processes to ultimately vitality and the survival of the trees. We've been searching for these questions: Are our forests ready for climate change? What physiological strategies do they use? Which tree species will be preferred in the future in Central Europe? And are there any bioindicators of changes observed at the level of physiological processes, which will also help to clarify the degree of environmental vulnerability and adaptive potential of the beech and spruce populations in terms of intra-species variability?

We have worked on several national (ENVIROSPRUCE and GROPECO) and international projects ([STReESS](#) – Studying Tree Responses to extreme Events: a SynthesiS and [CLIMO](#) – Climate Smart Forestry in Mountain Regions, to find out the answers and bring our results closer to forestry practitioners and stakeholders and also to define key considerations for implementing a climate-smart approach to development in the forest sector.

Spruce stands are expected to decline in the area of Central Europe, including natural mountain spruce stands (e.g. NNR Zadná Poľana, Slovakia) where the main factor determining their existence is the mountain climate. This has also been confirmed by our research, where growth responses based on the analysis of time series of growth and dendrometric proxy quantities, were mainly conditioned by temperature and beech shows a significant increase in radial increments compared to spruce. Montane spruce tends to be less temperature-demanding and more drought-sensitive than beech and [the improved competitiveness of beech](#) in this environment indicates a shift in the upper edge of its spread to higher altitudes in the Western Carpathians.

We have been studied [this ability of beech on intra-specific level with different European populations/provenances](#). Findings from experiment with one-year-old seedlings, in co-operation with researchers from the Thünen-Institute of Forest Ecosystems in Germany, indicated there was a different response to water stress among the considered beech populations. Drought mainly affected gas exchange describing a critical threshold of drought response between 30 and 26% SWA for photosynthetic rate. Similar experiment, but with 18-year-old trees of *Fagus sylvatica* was conducted on provenance plot in Central Slovakia. Provenances from the higher altitudes showed higher CO<sub>2</sub> assimilation rate, stomatal density, potential conductance indices and photochemical efficiency. A similar pattern of response was recorded in relation to the precipitation regime of sites of origin.

We are also getting started with the novel aspect an integrated approach to adaptation studies based on a combination genetic/genomic and ecophysiological research. Based on environmental association analysis at the population level of European beech, the *dehydrin* gene was found associated with drought-related climatic variables. At the individual level, [dehydrin gene](#) also showed a significant association with chlorophyll fluorescence parameters, which are considered stress markers. The importance of the knowledge of physiological variation and geographical patterns of



adaptive genetic variation for guiding reproductive materials transfer under climate change is stressed.

This combined approach will be further used and developed in the submitted SRDA project (Adaptive variation of genetic resources of forest trees under climate change), as well as link between research of multi-annual dynamics of changes of stem circumferences and analyses of stable isotopes in tree rings used in dendroclimatology.

### **Linking evolution and ecology of orthopteroids with ecosystems stability and socio-economic development**

In the long-term, one of the main interests of the Evolutionary and Behavioural Ecology Research Group has been focused on species diversity, colonisation mechanisms and adaptations in the environment. For this globally important topic with broad social and economic aspects in human population – from the community-based protection of local biodiversity, through pest control to the management of invasive species – we employed group of orthopteroid insects (crickets, grasshoppers and their allies) as a study system. During the evaluation period of the last six years we obtained several significant results there.

First of all, we gained [detailed knowledge](#) about distribution and biogeography of these species in the area including Pannonian and Carpathian regions, also thanks to a [citizen science project](#) led by our team. Using quantitative data we revised [biogeographical division](#) of Orthoptera in the central-European context and supported the importance of habitat diversity and heterogeneity for species richness. We found that the range of some species is divided by the influence of historical and rapid current changes in the environment and landscape. Species often survived in isolated areas with limited gene flow between populations. Therefore we studied population-genetic structures, characteristics of the phenotype and also the mechanisms by which [species adapt to changes in the environment](#) even after undergoing significant demographic bottleneck. This research was especially important for protected or endangered species that is important from the conservation point of view and indirectly also for the stability of entire ecosystems. We studied the effect of different gene flow on phenotypic expression as well as interspecific relationships in species with different evolutionary histories. We found that the body size may be related to current climatic conditions but, surprisingly, limited gene flow may be also important for [climate-induced selection](#) of adapted phenotypes. Our research on evolution of nuptial gift-giving bush-crickets contributed also to the understanding of [sexual conflict](#), which lies in different reproductive interest and parental investment of sexes, thus a problem familiar also to people.

Last but not least, we aimed to answer also fundamental questions of invasive biology that include the study of colonization history and mechanisms related to the success of species survival in the new environment. Identification of routes and pathways in which species have inhabited the area is essential for understanding the further development of their populations, their effects on the environment and other species, as well as the possible effects on human economic activities. Here we found that populations that were established by multiple founders or were introduced repeatedly had greater [colonization success](#), ensuring higher genetic diversity. Survival success was also influenced by the level of gene flow between populations. Our results suggested that cryptic lifestyle and increased resistance to inbreeding also enhance colonization success. Successful colonizers typically included species with high mobility. However, we discovered that immobile species can also be extremely successful and invasive, which, thanks to suitable vectors (cargo transport of goods) can colonize entire regions from a single population source and influence stability of native ecosystems.

### **From Commons to Carbon Neutral Societal Transformation**

Failure of Kyoto protocol in the late 1990's enhanced interdisciplinary research of nature and society interconnections to improve understanding of competing behavioural patterns and trigger behavioural change for long-term sustainability. It has created impetus for expansion of research networks, such as Human Dimension of Global Environmental Change (IHDP) or International Society for Ecological Economics (ISEE). By then, the Theory of Commons has celebrated 30th

birthday of addressing social dilemma and collective action in the management of natural resources under the scarcity and complexity of emerging global economy and climate change.

Our research on socio-ecological dimension of global change emerged as product of cooperation with Prof. Elinor Ostrom founder of the Theory of Commons and Nobel prize laureate (2009) around 2005, and particularly during her visit of Slovakia in 2007, when Lin participated in summer school 6FMP THEMES. Our team (SEA) assisted with common pool resource experiment conducted with subjects from 40 countries and formed the CETIP Network. After Commons Nobel Prize award, it has evolved into a supra-regional collaborative research network of Central and Eastern Europe on the Earth System Governance project (ESG) and ISEE, and the *Virtual laboratory of experimental social sciences* (VEEL) established as part of virtual commons lead by Arizona State University. Formation of SEA under the Institute of Forest Ecology in 2012 enhanced interdisciplinary collaboration for nature-society interactions, to celebrate 50th birthday of the Commons (2018) by emergence of [SlovakGlobe](#) – joint research centre with Slovak University of Technology hosting annual conference ESG in turbulent times in 2021.

Today, SEA benefits from national and more than 10 already conducted EU projects concentrated on the institutional ecological and experimental research on novel approaches in studying environmental governance for sustainability transformation, in particular:

Managing global change for societal transformation to sustainability concerns governance, business, and digital innovations to adapt to societal and natural disturbances in particular governance of the commons in climate vulnerable areas promoting concept of ecosystem services and voluntary incentive schemes (completed EU FM projects ECOFINDERS, SIMRA, Cost Actions PESFOR W, CLIMO) resulting in design of [carbon smart forestry principles empirically assessed](#) in several European forest landscapes and [in Island](#).

Behavioural change and knowledge co-production is targeting at the role of behavioral research to study variables of societal transformation to climate neutral societies. Recently we authored [typology of social innovations emergence](#) and development in marginalized rural areas (awarded as most cited article in the Sociologia Ruralis Journal over 2020-21). Novel component is Transdisciplinary model of knowledge coproduction developed under the recently completed H2020 project SIMRA.

Future plans are to expand theory of commons for carbon neutral transformation under two forthcoming Horizon Europe projects (wildE and COEVOLVERS, both 2022-2026).

2. In relation to research priority “***Disturbances in forest ecosystems***” we would like to highlight our following R&D activities:

### **Disturbances in spruce ecosystems**

Our study of disturbances in natural and man influenced spruce ecosystems focuses on two main areas. The first area is the study of the bark beetle attack and infestation spreading mechanism. We use information from tree ecophysiology measurements, health (vitality), and resistance to bark beetle attacks assessment on a tree and habitat level. Using data from remote sensing - a drone with advanced thermal and hyperspectral sensors or satellite data - we observe and model the spreading mechanism at the landscape level. The second area is the study of spruce–bark beetle interactions and the role of semiochemicals. We are also interested in semiochemicals applications (attractants and anti-attractants) in forest protection.

In recent years, we mainly studied the predisposition of spruce to bark beetle attacks on fresh forest edges. Our studies used tree physiology sensors, thermography, analytical chemistry, and drone remote sensing data. We have identified [tree physiology](#) and [chemistry changes](#) caused by acute stress caused by the sudden opening of the forest canopy by harvesting or natural biotic and abiotic disturbances. Those changes predispose spruce to bark beetle attack. On the landscape level, we have shown [the role of temperature](#) and [potential solar radiation](#) in the initialization and dynamic of bark beetle outbreak. These results are important for basic understanding of bark beetle related

disturbances and for practical decision making or management of spruce forest ecosystems, especially in protected areas on national, European and international levels.

We also improved semiochemical mixtures in dispensers to [better attract beetles to pheromone traps](#) or repel bark beetle attacks on trees. Our results help understand the chemical ecology of bark beetles, especially host-bark beetle interactions. New pheromone mixtures can help in practical forest protection.

We plan to incorporate molecular biology and genetics approaches in our studies, and we also plan to study spruces surviving bark beetle outbreaks. In the area of applications, we would like to work on more precise predictions of bark beetle attacks and the use of Artificial Intelligence in prediction models.

## **Insects in changing environment**

Oak forest decline connected with [aridization and outbreaks of moth larvae](#) in southern Slovakia were reasons to study this phenomenon in more detail. We assessed distribution of spring moth larvae defoliating oaks in forested stands with a closed canopy, groups of trees and solo trees. Different phenologies of *Quercus pubescens* (early-flushing) and *Quercus cerris* trees (late-flushing) influenced occurrence of larvae on the two oak species. Larvae showed greater ability to move from *Q. pubescens* to *Q. cerris* in closed canopy stands than in stands with solo trees. Common occurrence of early and late flushing oak species increased the risk of defoliation of late-flushing tree species in closed canopy stands. Drought and wind disturbances in mountain spruce forests strongly affected [spatial distribution and abundance of prominent species of bark beetle and their phoretic mite associates](#).

The expansion of native and non-native insect species into northern regions or higher altitudes is a characteristic response of insects to climate change. In cooperation with the Norwegian Institute of Bioeconomy Research we recorded the spread of the bark beetle *Ips amitinus* (physiological pest of Norway spruce) from its native range in Central Europe into the invaded range in northern Europe (Scandinavia). [The long-term dynamics of \*I. amitinus\*](#) did not differ between the native and invaded range of this species, however, its abundance was higher within the native range. Cooperation with the Forest Protection Service in Slovakia and United States Department of Agriculture enabled to investigate the accelerated [spread of the invasive ambrosia beetle \*Xylosandrus germanus\*](#) (timber pest) within Europe, from the West toward the East, and from lowland oak forests into submountain beech forests at higher elevations of the West Carpathians.

Invasive insect species are now recorded more often and in higher numbers on trees in urban habitats. We studied distribution of the invasive box [tree moth \*Cydalima perspectalis\* on box trees](#) (*Buxus* spp.) five years after invasion of this species to Slovakia. The probability of damage to box trees by the moth was decreasing with increasing altitude. The probabilities of high, medium or low damage by this serious pest of box trees were modelled for Slovakia, Czech Republic and Poland. High damage to box trees was highly likely up to 340 m a.s.l. In cooperation with the UK Centre for Ecology and Hydrology (COST European Information System for Alien Species) we compared [the ladybird communities on lime \(\*Tilia\* spp.\) and acer trees \(\*Acer\* spp.\)](#) between urban habitats in Slovakia, Czech Republic and England. The voracious invasive ladybird *Harmonia axyridis* was a predominant species in each urban habitat. A warm mesoclimate explained faster development of this successful invader in the central Prague than in its outskirts. Knowledge about the [biology and ecology of \*H. axyridis\*](#) has been summarized in a global study.

The results can be utilized by the forestry and horticultural practices and nature conservation.

## **2. Partial indicators of main activities:**

### **2.1. Research output**

#### **2.1.1. Principal types of research output of the institute: basic research/applied research, international/regional (in percentage)**

basic research / applied research: 90% / 10%

international / regional: 90% / 10%

#### **2.1.2 List of selected publications documenting the most important results of basic research. The total number of publications should not exceed the number of average FTE researchers per year. The principal research outputs (max. 10% of the total number of selected publications, including Digital Object Identifier – DOI if available) should be underlined. Authors from the evaluated organizations should be underlined.**

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### 2.1.3 List of monographs/books published abroad

HOCHKIRCH, Axel - NIETO, Ana - GARCÍA CRIADO, M. - CALIX, M. - BRAUD, Joan - BUZZETTI, Filippo - CHOBANOV, Dragan - ODÉ, Baudewijn - PRESA ASIENSO, Juan José - WILLEMSE, Luc - ZUNA-KRATKY, Thomas - BARRANCO VEGA, Pablo - BUSHELL, Mark - EULALIA CLEMENTE, Maria - CORREAS, José R. - DUSOULIER, François - FERREIRA, Sónia - FONTANA, Paolo - DOLORES GARCÍA, María - HELLER, Klaus-Gerhard - IORGU, Ionut Stefan - IVKOVIĆ, Slobodan - KATI, Vassiliki - KLEUKERS, Roy M. J. C. - KRIŠTÍN, Anton - LEMONNIER-DARCEMONT, Michèle - LEMOS, Paulo - MASSA, Bruno - MONNERAT, Christian - PAPAPAVLOU, Kelly P. - PRUNIER, Florent - PUSHKAR, Taras - ROESTI, Christian - RUTSCHMANN, Florin - ŞIRIN, Denis - SKEJO, Josip - SZÖVÉNYI, Gergely - TZIRKALLI, Elli - VEDENINA, Varvara - BARAT DOMENECH, Joan - BARROS, Francisco - CORDERO TAPIA, Pedro J. - DEFAULT, Bernard - GOMBOC, Stanislav - GUTIÉRREZ-RODRÍGUEZ, Jorge - HOLUŠA, J. - ILLICH, Inge - KARJALAINEN, Sami - KOČÁREK, Petr - KORSUNOVSKAYA, Olga - LIANA, Anna - LÓPEZ, Heriberto - OLMO-VIDAL, Josep María - PUSKÁS, Gellért - SAVITSKY, Vladimir - STALLING, Thomas - TUMBRINCK, Josef. *European Red List of grasshoppers, crickets and bush-crickets*. Luxembourg : Publications Office of the European Union, 2016. 88 p. ISBN 978-92-79-61751-5. <<https://portals.iucn.org/library/sites/library/files/documents/RL-4-021.pdf>>

*Anton Krištín as one of the authors of the monograph published by IUCN by Publishing house of European commission is a member of the Grasshopper Specialist Group IUCN as an employee of IFE SAS and the monograph was created as part of his work at the IFE SAS. The affiliation of any of the authors of the monograph is not mentioned there.*

JAKUŠ, Rastislav - BLAŽENEC, Miroslav - KOREŇ, Milan - BARKA, Ivan - LUKÁŠOVÁ, Karolína - LUBOJACKÝ, Jan - HOLUŠA, J. *TANABBO II model pro hodnocení rizika napadení lesních porostů lýkožroutem smrkovým Ips typographus (L.) [Coleoptera: Curculionidae] : certifikovaná metodika* [TANABBO II model for assessing the dynamics of the spruce bark beetle *Ips typographus* (L.): certified methodology.] Reviewers Jiří Foit, Štěpán Křístek. Jíloviště : Frestry and Game Management Research Institute, 2017. 69 p. Lesnický průvodce, 1/2017. ISBN 978-80-7417-135-2. <[http://www.vulhm.cz/sites/File/vydavatelska\\_cinnost/lesnicky\\_pruvodce/LP\\_1\\_2017.pdf](http://www.vulhm.cz/sites/File/vydavatelska_cinnost/lesnicky_pruvodce/LP_1_2017.pdf)>

ŠŤASTNÝ, Karel - KRIŠTÍN, Anton. *Ptáci Česka a Slovenska : Ottův obrazový atlas* [Czech and Slovak birds : Otto's Picture Atlas.] Pargue : Ottovo nakladatelství, s.r.o., 2021. 568 p. ISBN 978-80-7451-866-9

#### 2.1.4. List of monographs/books published in Slovakia

ČERNECKÝ, Ján - GAJDOŠ, Peter - ĎURICOVÁ, Viktória - ŠPULEROVÁ, Jana - ČERNECKÁ, Ľudmila - ŠVAJDA, Juraj - ANDRÁŠ, Peter - ULRYCH, Libor - RYBANIČ, Rastislav - POVAŽAN, Radoslav. *Hodnota ekosystémov a ich služieb na Slovensku* [Value of ecosystems and their services in Slovakia] [elektronický zdroj]. Recenzenti: Zita Izakovičová, Peter Mederly. Banská Bystrica : Štátna ochrana prírody SR, 2020. 166 s. Názov z pdf. súboru. Požaduje sa ADOBE READER. ISBN 978-80-8184-078-4 <<http://www.sopsr.sk/files/hodnota-ekosys.pdf>>

ČERNECKÝ, Ján - LEŠO, P. - RIDZOŇ, Jozef - KRIŠTÍN, Anton - KARASKA, Dušan - DAROLOVÁ, Alžbeta - FULÍN, Miroslav - CHAVKO, Jozef - BOHUŠ, Mirko - KRAJNIAK, Dušan - ĎURICOVÁ, Viktória - LEŠOVÁ, Andrea - ČULÁKOVÁ, Jana - SAXA, A. - DURKOŠOVÁ, Jana - ANDRÁŠ, Peter. *Stav ochrany vtáctva na Slovensku v rokoch 2013 –2018* [Conservation status of birds in 2013 – 2018 in Slovakia]. Recenzenti Peter Urban, Peter Puchala. Banská Bystrica : Štátna ochrana prírody SR, 2020. 105 s. ISBN 978–80–8184–084–5 <[http://www.sopsr.sk/news/file/Monografia\\_vtaky\\_reporting\\_18\\_12\\_2020.pdf](http://www.sopsr.sk/news/file/Monografia_vtaky_reporting_18_12_2020.pdf)>

GAJDOŠ, Peter - ČERNECKÁ, Ľudmila - FRANC, Valerián - ŠESTÁKOVÁ, Anna. *Pavúky Slovenska : slovenské názvoslovie, prehľad čeladi a súčasné poznatky* [Spiders of Slovakia. Slovak nomenclature, overview of families and present knowledge]. Recenzenti: Stanislav Pekár, Zuzana Krumpálová. Bratislava : Veda, 2018. 172 s. ISBN 978-80-224-1618-4

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PAŽITNÝ, Jozef - PÁSTOR, Michal - BOLVANSKÝ, Milan - BENČAĎ, Tibor. *Influence of site conditions on the incidence and spread of chestnut blight in Slovakia*. Zvolen : Technical University in Zvolen, 2019. 75 p. ISBN 978-80-228-3211-3

ŠPULEROVÁ, Jana - ŠTEFUNKOVÁ, Dagmar - DOBROVODSKÁ, Marta - IZAKOVIČOVÁ, Zita - KENDERESSY, Pavol - VLACHOVIČOVÁ, Miriam - LIESKOVSKÝ, Juraj - PISCOVÁ, Veronika - PETROVIČ, František - KANKA, Róbert - BAČA, Andrej - BARANČOKOVÁ, Mária - BEZÁK, Peter - BEZÁKOVÁ, Magdaléna - BOLTÍŽIAR, Martin - MOJSES, Matej - DUBCOVÁ, Magdaléna - GAJDOŠ, Peter - GERHÁTOVÁ, Katarína - IZSÓFF, Martin - KALIVODA, Henrik - MIKLÓSOVÁ, Viktória - DRÁBOVÁ, Monika - ŠATALOVÁ, Barbora - KRIŠTÍN, Anton - DANKANINOVÁ, Lenka - KALIVODOVÁ, Eva - MAJZLAN, Oto - MIHÁL, Ivan - STAŠIOV, Slavomír - ŠOLOMEKOVÁ, Tatiana - AMBROS, Michal - BALÁŽ, Ivan - HALABUK, Andrej. *Historické štruktúry poľnohospodárskej krajiny Slovenska : monografia získala ocenenie Zlatý Kosák od ministerky pôdohospodárstva a rozvoja vidieka p. Gabriely Matečnej na Agrokomplexe 2017 v Nitre* [Historical structures of agricultural landscape of Slovakia. The monograph was awarded "Zlatý Kosák" – "The Golden Sickel" by the Minister of Agriculture and Rural Development of the Slovak Republic – Gabriela Matečná at Agrokomplex 2017 in Nitra]. Recenzenti Mikuláš Huba, Zdeněk Lipský. Bratislava: Veda, 2017. 144 s. ISBN 978-80-224-1570-5 <[www.veda.sav.sk](http://www.veda.sav.sk)>



**2.1.5. List of other scientific outputs specifically important for the institute, max. 10 items for institute with less than 50 average FTE researchers per year, 20 for institutes with 50 – 100 average FTE researchers per year and so on**

ADAMČÍK, Slavomír\*\* - LOONEY, Brian P. - CABOŇ, Miroslav - JANČOVIČOVÁ, Soňa - ADAMČÍKOVÁ, Katarína - AVIS, Peter G. - BARAJAS, Magdalena - BHATT, Rajendra P. - CORRALES, Adriana - DAS, Kanad - HAMPE, Felix - GHOSH, Aniket - GATES, Genevieve - KÄLVIÄINEN, Ville - KHALID, Abdul N. - KIRAN, Munazza - DE LANGE, Ruben - HYUN, Lee - LIM, Young Woon - KONG, Alexandro - MANZ, Cathrin - OVREBO, Clark - SABA, Malka - TAIPALE, Tero - VERBEKEN, Annemieke - WISITRASSAMEEWONG, Komsit - BUYCK, Bart. The quest for a globally comprehensible Russula language. In *Fungal Diversity Journal*, 2019, vol. 99, no. 1, p. 369-449. (2018: 15.596 - IF, Q1 - JCR, 7.501 - SJR, Q1 - SJR). (2019 - Current Contents). ISSN 1560-2745. <https://doi.org/10.1007/s13225-019-00437-2>

ADAMSON, Kalev\*\* - LAAS, Marili - BLUMENSTEIN, Kathrin - BUSSKAMP, Johanna - LANGER, Gitta J. - KLAVINA, Darta - KAUR, Anu - MAATEN, Tiit - MULLETT, Martin S. - MÜLLER, Michael M. - ONDRUŠKOVÁ, Emília - PADARI, Allar - PILT, Enn - RIIT, Taavi - SOLHEIM, Halvor - SOONVALD, Liina - TEDERSOO, L. - TERHONEN, Eeva - DRENKHAN, Rein. Highly clonal structure and abundance of one haplotype characterise the *Diplodia sapinea* populations in Europe and Western Asia. In *Journal of Fungi*, 2021, vol. 7, iss. 8, art. no. 634. (2020: 5.816 - IF, Q1 - JCR, 1.702 - SJR, Q1 - SJR). (2021 - Current Contents). ISSN 2309-608X. <https://doi.org/10.3390/jof7080634>

ANGELSTAM, Per\*\* - ALBULESCU, Andra-Cosmina - ANDRIANAMBININA, Ollier Duranton F. - ASZALOS, Reka - BOROVICHEV, Eugene - CARDONA, Walter Cano - FEDORIAK, Maria - FIRM, Dejan - HUNTERJR., Malcolm - DE JONG, Wil - LINDENMAYER, David - MANTON, Michael - MONGE, Juan J. - MEZEI, Pavel - MICHAILOVA, Galina - MUÑOZ BRENES, Carlos L. - MARTÍNEZ PASTUR, Guillermo - PETROVA, Olga - PETROV, Victor - POKORNY, Benny - RAFANO HARANA, Serge C. - ROSAS, Yamina Micaela - SEYMOUR, Bob Robert - WAEBER, Patrick O. - WILMÉ, Lucienne - YAMELYNETS, Taras - ZLATANOV, Tzvelan. Frontiers of protected areas versus forest exploitation: Assessing habitat network functionality in 16 case study regions globally. In *Ambio : journal of human environment*, 2021, vol. 50, iss. 12, p. 2286–2310. (2020: 5.129 - IF, Q2 - JCR, 1.564 - SJR, Q1 - SJR). (2021 - Current Contents). ISSN 0044-7447. <https://doi.org/10.1007/s13280-021-01628-5>

BOWDITCH, Euan - SANTOPOULI, Giovanni\*\* - BINDER, Franz - DEL RIO, Miren - LA PORTA, Nicola - KLUVÁNKOVÁ, Tatiana - LESINSKI, Jerzy - MOTTA, Renzo - PACH, Maciej - PANZACCHI, Pietro - PRETZSCH, Hans - TEMPERLI, Christian - TONON, Giustino - SMITH, Melanie - VELIKOVA, Violeta - WHEATHERALL, Andrew - TOGNETTI, Roberto. What is climate-smart forestry? A definition from a multinational collaborative process focused on mountain regions of Europe. In *Ecosystem Services*, 2020, vol. 43, art. no. 101113. (2019: 6.330 - IF, Q1 - JCR, 2.672 - SJR, Q1 - SJR). (2020 - Current Contents). ISSN 2212-0416. <https://doi.org/10.1016/j.ecoser.2020.101113>

CROUS, P.W.\*\* - WINGFIELD, M.J. - BURGESS, T.I. - HARDY, G.E.St.J. - GENE, J. - GUARRO, Joan - BASEIA, I.G. - GARCIA, D. - GUSMAO, L.F.P. - SOUZA-MOTTA, C.M. - THANGAVEL, R. - ADAMČÍK, Slavomír - BARILI, A. - BARNES, C.W. - BEZERRA, J.D.P. - BORDALLO, J.J. - CANO-LIRA, J.F. - OLIVEIRA, R.J.V. - ERCOLE, Enrico - HUBKA, V. - ITTURIETA-GONZALEZ, I. - KUBÁTOVÁ, A. - MARTIN, M.P. - MOREAU, Pierre-Arthur - MORTE, A. - ORDONEZ, M.E. - RODRIGUEZ, A. - STCHIGEL, A.M. - VIZZINI, Alfredo - ABDOLLAHZADEH, J. - ABREU, V.P. - ADAMČÍKOVÁ, Katarína - ALBUQUERQUE, G.M.R. - ALEXANDROVA, A.V. - DUARTE, E. Alvarez - ARMSTRONG-CHO, C. - BANNIZA, S. - BARBOSA, R.N. - BELLANGER, J.M. - BEZERRA, J.L. - CABRAL, T.S. - CABOŇ, Miroslav - CAICEDO, E. - CANTILLO, T. - CARNEGIE, A.J. - CARMO, LT - CASTANEDA-RUIZ, R.F. - CLEMENT, C.R. - CMOKOVÁ, Adela - CONCEICAO, L.B. - CRUZ, R.H.S.F. - DAMM, U. - DA SILVA, B.D.B. - DA SILVA, R.M.F. - SANTIAGO, A.L.C.M. de A. - DE SOUZA, C.A.F. - DENIEL, F. - DIMA, Bálint - DONG, G. - EDWARDS, J. - FELIX, C.R. - FOURNIER, F. - GIBERTONI, T.B. - HOSAKA, K. - ITURRIAGA, T. - JADAN, M. - JANY, J.L. - JURJEVIC, Z. - KOLAŘÍK, Miroslav - KUSAN, I. - LANDELL, M.F. - CORDEIRO, T.R.L. - LIMA, D.X. - LOIZIDES, M. - LUO, S. - MACHADO, Alexandre R. - MADRID, H. - MAGALHAES, O.M.C. - MARINHO, P. -



MATOTEC, N. - MESIC, A. - MILLER, Andrew N. - MOROZOVA, O.V. - NEVES, R.P. - NONAKA, K. - NOVÁKOVÁ, A. - OBERLIES, N.H. - OLIVEIRA-FILHO, J.R.C. - OLIVEIRA, T.G.L. - PAPP, V. - PEREIRA, Olinto L. - PERRONE, G. - PETERSON, S.W. - PHAM, T.H.G. - RAJA, H.A. - RAUDABAUGH, D.B. - REHULKA, J. - RODRIGUEZ-ANDRADE, E. - SABA, M. - SCHAUFLEROVÁ, A. - SHIVAS, R.G. - SIMONINI, G. - SIQUEIRA, J.P.Z. - SOUSA, J.O. - STAJŠIC, V. - SVETASHEVA, T. - TAN, Y.P. - TKALCEC, Z. - ULLAH, S. - VALENTE, P. - VALENZUELA-LOPEZ, N. - ABRINBANA, M. - MARQUES, D. A. Viana - WONG, P.T.W. - DE LIMA, V. Xavier - GROENEWALD, J.Z. Fungal Planet description sheets: 716-784. In *Persoonia*, 2018, vol. 40, p. 240-393. (2017: 8.182 - IF, Q1 - JCR, 5.633 - SJR, Q1 - SJR). (2018 - Current Contents). ISSN 0031-5850. <https://doi.org/10.3767/persoonia.2018.40.10>

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#### **2.1.6. List of patents, patent applications, and other intellectual property rights registered abroad**

N/A

#### **2.1.7. List of patents, patent applications, and other intellectual property rights registered in Slovakia**

Number PV: 288591

Date: 04/07/2018

Authors: Barta Marek, Kautmanová Ivona, Kozánek Milan, Čičková Helena

Patent name: Vysokovirulentný kmeň entomopatogénnej huby *Beauveria bassiana* DSM 32081 na použitie v bioregulácii lykožrúta smrekového. [Highly virulent strain of entomopathogenic fungus *Beauveria bassiana* DSM32081 for use in biocontrol of spruce bark beetle.]

Co-owner: Scientica, s.r.o., Bratislava, SK

## **2.1.8. Narrative on the most important research outputs of the institute – especially focused on their importance for society (3-5 pages)**

### **1. An agent-based algorithm resembles behaviour of tree-dwelling bats under fission-fusion dynamics**

During the last 20 years at the institute, the study of ecology and behaviour of forest and tree-dwelling bats resulted in almost 30 scientific papers or book chapters. There we explored different topics, from the roost-site selection, habitat use, spatio-temporal foraging activity and diet spectra, through social and genetic structures of populations to swarming behaviour of maternity colonies. The later mentioned topic has fascinated us by its impressive visual complexity and putative randomness. Tree-dwelling bats live in highly dynamic fission-fusion societies that share multiple roosts in a common home range. The key behavioural component associated with complex and non-centralized decision-making processes in roost switching is swarming around potential locations (tree cavities) in order to recruit members to the new roost. However, besides advanced biological research tools and methods, in-depth investigation of this behaviour required an assistance from different scientific discipline. Because utilization of computational approach in the study of social behaviour of animals is increasing, we attempted such an approach in our study of tree-dwelling bats too. To understand roost switching dynamics of bat groups in their natural environment, we employed a computational model, [the SkyBat](#), which is based on swarm algorithm, to model this process. This model is created in cooperation with the Institute of Informatics SAS in Bratislava since 2017 and currently developed and further tested thanks to the grant by the Slovak Research and Development Agency (APVV-17-0116 Algorithm of collective intelligence: Interdisciplinary study of swarming behaviour in bats). In a simulated environment of this agent-based model, we replicated natural fission-fusion dynamics of the Leisler's bat, *Nyctalus leisleri*, groups according to predefined species and habitat parameters. Spatio-temporal patterns of swarming activity of agents were similar to bats. The number of simulated groups formed prior to sunrise, the mean number of individuals in groups and the roost height did not differ significantly from data on a local population of bats collected in the field. Thus, the swarm algorithm gave a framework of roost-switching, suggesting possible applications in the study of bat behaviour in rapidly changing environments as well as in the field of computer science. *A highly potential candidate for utilization of the SkyBat algorithm is swarm robotics, an emerging bio-inspired approach that aims to coordinate a large number of autonomous robots in searching for specific targets of interest and moving groups from one location to another without a leader.*

### **2. Storms, temperature maxima and the Eurasian spruce bark beetle *Ips typographus* —An infernal trio in Norway spruce forests of the Central European High Tatra Mountains.**

Natural disturbances are part of forest ecosystem dynamics, affecting their structure and functions. Our institute commits to the study of natural disturbances such as wind and bark beetle outbreaks. Several high-quality outputs were published within this field from our institute. To pick one, we went for the one focusing on *the interaction of climate, bark beetles and wind disturbances in the northern part of the High Tatra National park*. This study combines remote sensing data, long-term meteorological data, forestry databases, retrospective phenological modelling of bark beetle population dynamics and advanced statistical methods to select the best variables for explaining the disturbances.

One of the surprising fact regarding natural disturbances in mountainous areas is that in the period from 1990 to 2020, two bark beetle outbreaks occurred – which was not usual in the past. To understand which environmental factors are affecting bark beetle population dynamics and subsequent tree mortality, we employed the Information-Theory for selecting the best parsimonious model. *The Phenips phenology model*, developed at the University of Natural Resources and Life Science in Vienna was also used as a standalone application in R-framework programmed by the team at IFE.

We explored different explanatory variables, from temperature sums to precipitation and temporal population dynamics of the European spruce bark beetle (*Ips typographus*) to find the driving factors behind these changes. *The key component associated with *I. typographus* population dynamics and tree mortality was the maximum temperature sum.* However, *the main trigger was the occurrence of*

high temperature sums during the vegetation season and recent wind disturbances. This study was created in cooperation with other institutions of the SAS and Universities in Slovakia and Austria.

In our simulations, we modelled bark beetle population dynamics retrospectively. The temporal patterns of bark beetle caused tree mortality were the strongest when suitable conditions for bark beetle sister brood were present. In years with sister generations, tree mortality differed significantly from years with colder temperatures. This and other similar studies from the IFE SAS have a high potential for utilization as a scenario building model as a support and input for decision making in forestry and ecology.

### **3. In planta bioassay on the effects of endophytic *Beauveria* strains against larvae of horse-chestnut leaf miner (*Cameraria ohridella*)**

Entomopathogenic fungi, such as *Beauveria species*, have been the focus of study at the institute over the past 15 years. The research resulted in almost 30 papers which demonstrated that these fungi were functional as microbial insecticides under laboratory conditions. However, when the fungi were applied against insects in the field, the efficacy was reduced due to adverse abiotic factors (including temperature, humidity, solar radiation, etc.). To eliminate these environmental factors, the hypothesis of using these fungi as endophytes in plants against insect pests was tested as a novel control strategy. It is known that certain entomopathogenic fungi can form endophytic associations with plants. For example, *Beauveria* species have been found naturally as endophytes in a number of plant species, and they have been artificially introduced into many others.

The essential question was whether entomopathogenic fungi might be used as plant endophytes for the biological control of herbivore insects. The horse-chestnut leaf miner, *Cameraria ohridella*, and the horse-chestnut tree (*Aesculus hippocastanum*) were tested as model organisms. The horse-chestnut leaf miner is a major pest of horse-chestnut trees in Europe, and the trees are often completely defoliated by early summer. The damage is particularly spectacular in cities where horse-chestnut trees are abundant and the defoliated trees in parks and gardens raise public concern. Attempts to effectively control the leaf miner are usually unsuccessful, particularly in public parks and gardens where the use of chemical insecticides is restricted.

The *Beauveria* fungi were artificially established as endophytes in horse-chestnut leaves, and the observations demonstrated that damage by the miner was significantly lower in endophyte-colonized leaves than in non-colonized trees. The damaged leaf area of colonized leaves was smaller compared to non-colonized leaves and the survivorship of leaf miners was significantly reduced. Pupae that completed their development in colonized leaves had significantly reduced size and weight. The results indicated that *Beauveria* strains colonizing leaves effectively exhibited insecticidal effects when growing inside the horse-chestnut tissue. These findings support the hypothesis that [entomopathogenic fungi as endophytes can offer a new way to protect plants from pests](#) while reducing the risk of using pesticides.

### **4. Altitude of origin influences the responses of PSII photochemistry to heat waves in European beech (*Fagus sylvatica*)**

Climate is the most important ecological factor influencing tree composition and contributing to species diversity, while playing a central role in shaping the overall performance of forest ecosystems. Global climate change is expected to increase the frequency, intensity and duration of extreme stress events that may adversely affect forest communities and limit their ability to provide a full range of ecosystem services. In the context of these facts, last years we have focused on beech (*Fagus sylvatica*) and its physiological vitality as one of the economically and ecologically most important tree species in Europe. Due to its high genetic diversity and phenotypic plasticity, *F. sylvatica* is successfully adapted to different environments and altitudinal zones within its natural range. In the northern parts of its distribution, beech populations occupy sites at low elevation (e.g. Denmark 0–150 m, Germany 30 m) whereas, in central and southern areas, it is found at elevations of 1000 m a. s.l. However, although occupying a large geographic range, beech is supposed to suffer high mortality rates in Central Europe, due to high vulnerability to heat and drought stress.



Thanks to grants support from the Agency for Research and Development Support (APVV-0135-12 - Adaptive genetic potential of forest tree populations in the context of climate changes and APVV- 0480-12 - Nutrient-energy cycles as disturbance indicators of terrestrial ecosystems) we were able to move beech research from the laboratory - research of seedlings and saplings to the plot - research of young trees; and from extend monitoring to the level of provenance research. Provenance experiments as one type of common gardens, where the populations of different origins are planted on the same site and their reactions to transfer are examined, have been an important source of information on climatic adaptation of trees. We identified of environmental vulnerability and adaptive potential of European beech provenances by the photosynthetic techniques. The photosynthetic responses to the combined effect of drought and heat stress were studied in 19-years-old European beech trees originating from five provenances in Central Europe differing by altitude (55–1250 m).

We observed distinct response of PSII photochemistry on combined drought and high temperature stress, well associated with altitude of origin of the beech provenances. Measurements of pulse amplitude modulated (PAM) fluorescence identified maintenance of a high electron transport rate in beech provenances from high altitudes under drought and heat wave conditions, associated with some decrease of excitation pressure on PSII. This can be explained by enhanced capacity of alternative electron sinks to utilize the excess of electrons as a photoprotective mechanism. The analyses of fast chlorophyll fluorescence kinetics confirmed the differences in responses of PSII photochemistry between provenances originating from different altitudes. Compared with provenances at higher altitudes, we found more sensitive response (i.e. more limited electron transport at the PSII acceptor side and changes in the size of light harvesting complexes) to drought and heat stress, in those growing at low altitudes. Our results support the hypothesis that [the provenances originating from higher altitudes possess enhanced phenotypic plasticity related to photoprotective responses](#), resulting from the long-term adaptation to marginal mountain conditions.

Utilization of the available genetic variation in climate responses and testing of alternative provenances suitable for future climatic conditions are considered important adaptation measures in forestry.

## **5. Managing global change for societal transformation — Understanding social innovation for the well-being of forest-dependent communities: A preliminary theoretical framework.**

The governance of nature is facing remarkable dynamics resulted from massive societal challenges including land-use, climate change, food insecurity, carbon intensity, biodiversity losses, pandemics, facing economic-climate-environmental-health security crises. To address these challenges, SEA has concentrates on transdisciplinary research on managing global change for societal transformation to sustainability. In particular, the concern is in determining key incentives to support climate smart forestry explored under the [Cost Action CLIMO](#) and the power of social innovation to steer sustainable governance of nature in Marginalized Rural Areas, such as to promote climate smart community forestry ([SIMRA](#)). Intense international collaboration resulted in several scientific papers and 2 book chapters. Research team of cross work packages lead by SEA successfully developed a [transdisciplinary framework](#) to understand the role of social innovations in supporting climate and rural cohesion via well-being of forest-dependent communities. Forests provide numerous benefits to society; however, the potential of forest communities to deliver multiple benefits has remained largely unexplored. Built on knowledge coproduction, interactive stakeholders' and civil society actors' engagement it presents an original definition of social innovations for marginalized rural areas to see social innovations as collective action, which is nurtured or constrained by its socio-economic and environmental context that frames the dynamics of natural and social disturbances. The novelty provided includes showing that in marginalised rural areas, where people have disadvantages and strongly depend on nature, social innovation has a high potential to deliver value and make a difference for both local communities and natural ecosystems by providing innovative solutions and novel policy practice at different levels, with the ultimate aim of building resilience.



### 2.1.9. Table of research outputs

Papers from international collaborations in large-scale scientific projects (Dwarf team, ALICE Collaboration, ATLAS collaboration, CD Collaboration, H1 Collaboration, HADES Collaboration, and STAR Collaboration) have to be listed separately

Scientific publications	2016			2017			2018			2019			2020			2021			total			
	number	No. / FTE researches	No. / one million total salary budget	number	No. / FTE researches	No. / one million total salary budget	number	No. / FTE researches	No. / one million total salary budget	number	No. / FTE researches	No. / one million total salary budget	number	No. / FTE researches	No. / one million total salary budget	number	No. / FTE researches	No. / one million total salary budget	number	averaged number per year	av. No. / FTE researches	av. No. / one million total salary budget
Scientific monographs and monographic studies in journals and proceedings published abroad ( <i>AAA, ABA</i> )	1	0.017	0.758	1	0.016	0.681	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	1	0.024	0.533	3	0.500	0.010	0.303
Scientific monographs and monographic studies in journals and proceedings published in Slovakia ( <i>AAB, ABB</i> )	0	0.000	0.000	1	0.016	0.681	1	0.021	0.631	1	0.021	0.566	2	0.044	1.057	3	0.073	1.600	8	1.333	0.026	0.808
Chapters in scientific monographs published abroad ( <i>ABC</i> )	1	0.017	0.758	0	0.000	0.000	0	0.000	0.000	2	0.043	1.132	0	0.000	0.000	0	0.000	0.000	3	0.500	0.010	0.303
Chapters in scientific monographs published in Slovakia ( <i>ABD</i> )	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	3	0.073	1.600	3	0.500	0.010	0.303
Scientific papers published in journals registered in Current Contents Connect ( <i>ADCA, ADCB, ADDA, ADEB</i> )	31	0.534	23.485	28	0.438	19.074	29	0.619	18.308	37	0.793	20.939	53	1.167	27.998	44	1.068	23.467	222	37.000	0.735	22.408
Scientific papers published in journals registered in Web of Science Core Collection and SCOPUS not listed above ( <i>ADMA, ADMB, ADNA, ADNB</i> )	7	0.121	5.303	18	0.282	12.262	12	0.256	7.576	15	0.321	8.489	27	0.594	14.263	13	0.316	6.933	92	15.333	0.304	9.286
Scientific papers published in other foreign journals (not listed above) ( <i>ADEA, ADEB</i> )	1	0.017	0.758	2	0.031	1.362	0	0.000	0.000	0	0.000	0.000	1	0.022	0.528	0	0.000	0.000	4	0.667	0.013	0.404
Scientific papers published in other domestic journals (not listed above) ( <i>ADFA, ADFB</i> )	8	0.138	6.061	4	0.063	2.725	0	0.000	0.000	4	0.086	2.264	2	0.044	1.057	2	0.049	1.067	20	3.333	0.066	2.019
Scientific papers published in foreign peer-reviewed proceedings ( <i>AECA</i> )	9	0.155	6.818	3	0.047	2.044	5	0.107	3.157	3	0.064	1.698	0	0.000	0.000	2	0.049	1.067	22	3.667	0.073	2.221
Scientific papers published in domestic peer-reviewed proceedings ( <i>AEDA</i> )	2	0.034	1.515	1	0.016	0.681	4	0.085	2.525	2	0.043	1.132	2	0.044	1.057	0	0.000	0.000	11	1.833	0.036	1.110
Published papers (full text) from foreign scientific conferences ( <i>AFA, AFC</i> )	0	0.000	0.000	8	0.125	5.450	3	0.064	1.894	4	0.086	2.264	1	0.022	0.528	1	0.024	0.533	17	2.833	0.056	1.716
Published papers (full text) from domestic scientific conferences ( <i>AFB, AFD</i> )	14	0.241	10.606	4	0.063	2.725	21	0.448	13.258	5	0.107	2.830	1	0.022	0.528	0	0	0	45	8	0	5

## 2.2. Measures of research outputs (citations, etc.)

### 2.2.1. Table with citations per annum (without self-citations)

*Citations of papers from international collaborations in large-scale scientific projects (Dwarf team, ALICE Collaboration, ATLAS collaboration, CD Collaboration, H1 Collaboration, HADES Collaboration, and STAR Collaboration) are listed separately*

Citations, reviews	2015		2016		2017		2018		2019		2020		total		
	number	No. / FTE researchers	number	No. / FTE researchers	number	No. / FTE researchers	number	No. / FTE researchers	number	No. / FTE researchers	number	No. / FTE researchers	number	averaged number per year	av. No. / FTE researchers
Citations in Web of Science Core Collection (1.1, 2.1)	173	2.98	249	3.89	371	7.91	383	8.21	488	10.74	636	15.44	2 300	383.33	7.61
Citations in SCOPUS (1.2, 2.2) if not listed above	58	1.00	92	1.44	91	1.94	57	1.22	51	1.12	9	0.22	358	59.67	1.18
Citations in other citation indexes and databases (not listed above) (3.2,4.2)	5	0.09	11	0.17	29	0.62	11	0.24	9	0.20	12	0.29	77	12.83	0.25
Other citations (not listed above) (3.1, 4.1)	140	2.41	157	2.46	99	2.11	67	1.44	109	2.40	69	1.68	641	106.83	2.12
Reviews (5,6)	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0.00

## 2.2.2. List of 10 most-cited publications published any time with the address of the institute, with number of citations in the assessment period (2015 – 2020)

ROY, Helen E. - BROWN, Peter M. J. - ADRIAENS, Tim - BERKVEN, Nick - BORGES, Isabel - CLUSELLA-TRULLAS, Susana - COMONT, Richard F - DE CLERCQ, Patrick - ESCHEN, René - ESTOUP, Arnaud - EVANS, Edward W. - FACON, Benoit - GARDINER, Mary M. - GIL, Artur - GREZ, Audrey A. - GUILLEMAUD, Thomas - HAELEWATERS, Danny - HERZ, Anette - HONĚK, Alois - HOWE, Andrew Gordon - HUI, Cang - HUTCHISON, William D. - KENIS, Marc - KOCH, Robert L. - KULFAN, Ján - HANDLEY, Lori Lawson - LOMBAERT, Eric - LOOMANS, Antoon - LOSEY, John E. - LUKASHUK, Alexander O. - MAES, Dirk - MAGRO, Alexandra - MURRAY, Katie M. - SAN MARTIN, Gilles - MARTINKOVÁ, Zdenka - MINNAAR, Ingrid A. - NEDVĚD, Oldřich - ORLOVA-BIENKOWSKAJA, Marina - OSAWA, Naoya - RABITSCH, Wolfgang - RAVN, H. P. - RONDONI, Gabriele - RORKE, Steph L. - RYNDEVICH, Sergey K. - SAETHRE, May-Guri - SLOGGETT, John J. - SOARES, Antonio Onofre - STALS, Riaan - TINSLEY, Mathew C. - VANDEREYCKEN, Axel - VAN WIELINK, Paul S. - VIGLÁŠOVÁ, Sandra - ZACH, Peter - ZAKHAROV, Ilya A. - ZAVIEZO, Tania - ZHAO, Zihua. The harlequin ladybird, *Harmonia axyridis*: global perspectives on invasion history and ecology. In *Biological Invasions*, 2016, vol. 18, iss. 4, p. 997-1044. (2015: 2.855 - IF, Q1 - JCR, 1.462 - SJR, Q1 - SJR, karentované - CCC). (2016 - Current Contents). ISSN 1387-3547. Dostupné na: <https://doi.org/10.1007/s10530-016-1077-6>  
Citacions: **103**

DJUKIC, Ika\*\* - KEPFER-ROJAS, Sebastian - SCHMIDT, Inger Kappel - LARSEN, Klaus Steenberg - BEIER, Claus - BERG, B. - VERHEYEN, Egon - MIHÁL, Ivan - BOROVSÁ, Jana - GERHÁTOVÁ, Katarína - BARNA, Milan - KANKA, Róbert - PISCOVÁ, Veronika - CALIMAN, Adriano - PAQUETTE, Alain - GUTIÉRREZ-GIRÓN, Alba - HUMBER, Alberto - VALDECANTOS, Alejandro - PETRAGLIA, Alessandro - ALEXANDER, Heather - AUGUSTAITIS, Algirdas - SAILLARD, Amélie - RUIZ FERNÁNDEZ, Ana Carolina - SOUSA, Ana I. - LILLEBO, Ana I. - DA ROCHA GRIPP, Anderson - FRANCEZ, André-Jean - FISCHER, Andrea - BOHNER, Andreas - MALYSHEV, Andrey - ANDRIĆ, Andrijana - SMITH, Andy - STANISCI, Angela - SERES, Anikó - SCHMIDT, Anja - AVILA, Anna - PROBST, Anne - OUIN, Annie - KHUROO, Anzar A. - VERSTRAETEN, Arne - PALABRAL-AGUILERA, Arely N. - STEFANSKI, Artur - GAXIOLA, Aurora - MUYS, Bart - BOSMAN, Bernard - AHREND, Bernd - PARKER, Bill - SATTLER, Birgit - YANG, Bo - JURÁNI, Bohdan - ERSCHBAMER, Brigitta - RODRIGUEZ ORTIZ, Carmen Eugenia - CHRISTIANSEN, Casper T. - ADAIR, E. Carol - MEREDIEU, Céline - MONY, Cendrine - NOCK, Charles A. - CHEN, Chi-Ling - WANG, Chiao-Ping - BAUM, Christel - RIXEN, Christian - DELIRE, Christine - PISCART, Christophe - ANDREWS, Christopher - REBMANN, Corinna - BRANQUINHO, Cristina - POLYANSKAYA, Dana - DELGADO, David Fuentes - WUNDRAM, Dirk - RADEIDEH, Diyaa - ORDÓÑEZ-REGIL, Eduardo - CRAWFORD, Edward - PREDA, Elena - TROPINA, Elena - GRONER, Elli - LUCOT, Eric - HORNUNG, Erzsébet - GACIA, Esperança - LÉVESQUE, Esther - BENEDITO, Evanilde - DAVYDOV, Evgeny A. - AMPOORTER, Evy - BOLZAN, Fabio Padilha - VARELA, Felipe - KRISTÖFEL, Ferdinand - MAESTRE, Fernando T. - MAUNOURY-DANGER, Florence - HOFHANS, Florian - KITZ, Florian - SUTTER, Flurin - CUESTA, Francisco - DE ALMEIDA LOBO, Francisco - DE SOUZA, Franco Leandro - BERNINGER, Frank - ZEHETNER, Franz - WOHLFAHRT, Georg - VOURLITIS, George - CARREÑO-ROCABADO, Geovana - ARENA, Gina - PINHA, Gisele Daiane - GONZÁLEZ, Grizelle - CANUT, Guylaine - LEE, H. - VERBEECK, Hans - AUGÉ, Harald - PAULI, Harald - NACRO, Hassan Bismarck - BAHAMONDE, Héctor A. - FELDHAAR, Heike - JÄGER, Heinke - SERRANO, Helena C. - VERHEYDEN, Héléne - BRUELHEIDE, Helge - MEESBURG, Henning - JUNGKUNST, Hermann - JACTEL, Hervé - SHIBATA, Hideaki - KUROKAWA, Hiroko - ROSAS, Hugo López - VILLALOBOS, Hugo L. Rojas - YESILONIS, Ian - MELECE, Inara - VAN HALDER, Inge - QUIRÓS, Inmaculada García - MAKELELE, Isaac - SENOU, Issaka - FEKETE, István - OSTONEN, Ivika - ROALES, Javier - SHOQEIR, Jawad - LATA, Jean-Christophe - THEURILLAT, Jean-Paul - PROBST, Jean-Luc - ZIMMERMAN, Jess - VIJAYANATHAN, Jeyanny - TANG, Jianwu - THOMPSON, Jill - DOLEŽAL, Jiří - SANCHEZ-CABEZA, Joan-Albert - MERLET, Joël - HENSCH, Joh - NEIRYNCK, Johan - KNOPS, Johannes - LOEHR, John - VON OPPEN, Jonathan - PORLÁKSDÓTTIR, Jónína Sigríður - LÖFFLER, Jörg - CARDOSO-MOHEDANO, José-Gilberto - ALONSO, José Luis Benito - TOREZAN, Jose Marcelo - MORINA, Joseph C. - JIMÉNEZ, Juan J. - QUINDE, Juan Dario -

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Citacions: **33**

*Anton Krištín as one of the authors of the monograph published by IUCN by Publishing house of European commission is a member of the Grasshopper Specialist Group IUCN as an employee of IFE SAS and the monograph was created as part of his work at the IFE SAS. The affiliation of any of the authors of the monograph is not mentioned there.*

MEZEI, Pavel - JAKUŠ, Rastislav - PENNERSTORFER, Josef - HAVAŠOVÁ, Mária - ŠKVARENINA, Jaroslav - FERENČÍK, J. - SLIVINSKÝ, J. - BIČAROVÁ, Svetlana - BILČÍK, Dušan - BLAŽENEC, Miroslav - NETHERER, Sigrid. Storms, temperature maxima and the Eurasian spruce bark beetle *Ips typographus*—An infernal trio in Norway spruce forests of the Central European High Tatra Mountains. In *Agricultural and Forest Meteorology*, 2017, vol. 242, p. 85-95. (2016: 3.887 - IF, Q1 - JCR, 2.047 - SJR, Q1 - SJR, karentované - CCC). (2017 - Current Contents). ISSN 0168-1923. Dostupné na: <https://doi.org/10.1016/j.agrformet.2017.04.004>  
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Citacions: **31**

BOLTE, A. - CZAJKOWSKI, T. - COCOZZA, Claudia - TOGNETTI, Roberto - DE MIGUEL, Marina - PŠIDOVÁ, Eva - DITMAROVÁ, Ľubica - DINCA, Lucian - DELZON, Sylvain - COCHARD, Hervé - RÆBILD, Anders - DE LUIS, Martin - CVJETKOVIC, Branislav - HEIRI, Caroline - MÜLLER, Jürgen. Desiccation and mortality dynamics in seedlings of different European beech (*Fagus sylvatica* L.) populations under extreme drought conditions. In *Frontiers in Plant Science*, 2016, vol. 7, art. no. 751. (2015: 4.495 - IF, Q1 - JCR, 2.044 - SJR, Q1 - SJR, karentované - CCC). (2016 - Current Contents). ISSN 1664-462X. Dostupné na: <https://doi.org/10.3389/fpls.2016.00751>  
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Citacions: **26**



### 2.2.3. List of 10 most-cited publications published any time with the address of the institute, with number of citations obtained until 2020

*Rozšírenie vtákov na Slovensku* = Birds distribution in Slovakia. Eds. Štefan Danko, Alžbeta Darolová, Anton Krištín. Bratislava : Veda, 2002. 688 s. ISBN 80-224-0714-3.

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*Anton Krištín as one of the editors and main authors of this monograph published in the VEDA Publishing house is an employee of IFE SAS, while the monograph was created as part of his VEGA projects at IFE SAS 2/7025/00 and 2/2001/02 (listed in the publication). The affiliation of any of the authors of the monograph is not mentioned there.*

ROY, Helen E. - BROWN, Peter M. J. - ADRIAENS, Tim - BERKVEN, Nick - BORGES, Isabel - CLUSELLA-TRULLAS, Susana - COMONT, Richard F - DE CLERCQ, Patrick - ESCHEN, René - ESTOUP, Arnaud - EVANS, Edward W. - FACON, Benoit - GARDINER, Mary M. - GIL, Artur - GREZ, Audrey A. - GUILLEMAUD, Thomas - HAELEWATERS, Danny - HERZ, Anette - HONĚK, Alois - HOWE, Andrew Gordon - HUI, Cang - HUTCHISON, William D. - KENIS, Marc - KOCH, Robert L. - KULFAN, Ján - HANDLEY, Lori Lawson - LOMBAERT, Eric - LOOMANS, Antoon - LOSEY, John E. - LUKASHUK, Alexander O. - MAES, Dirk - MAGRO, Alexandra - MURRAY, Katie M. - SAN MARTIN, Gilles - MARTINKOVÁ, Zdenka - MINNAAR, Ingrid A. - NEDVĚD, Oldřich - ORLOVA-BIENKOWSKAJA, Marina - OSAWA, Naoya - RABITSCH, Wolfgang - RAVN, H. P. - RONDONI, Gabriele - RORKE, Steph L. - RYNDEVICH, Sergey K. - SAETHRE, May-Guri - SLOGGETT, John J. - SOARES, Antonio Onofre - STALS, Riaan - TINSLEY, Mathew C. - VANDEREYCKEN, Axel - VAN WIELINK, Paul S. - VIGLÁŠOVÁ, Sandra - ZACH, Peter - ZAKHAROV, Ilya A. - ZAVIEZO, Tania - ZHAO, Zihua. The harlequin ladybird, *Harmonia axyridis*: global perspectives on invasion history and ecology. In *Biological Invasions*, 2016, vol. 18, iss. 4, p. 997-1044. (2015: 2.855 - IF, Q1 - JCR, 1.462 - SJR, Q1 - SJR, karentované - CCC). (2016 - Current Contents). ISSN 1387-3547. Dostupné na: <https://doi.org/10.1007/s10530-016-1077-6>

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Citacions: **49**

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Citacions: **48**

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ROY, Helen E. - BROWN, Peter M. J. - ADRIAENS, Tim - BERKVEN, Nick - BORGES, Isabel - CLUSELLA-TRULLAS, Susana - COMONT, Richard F - DE CLERCQ, Patrick - ESCHEN, René - ESTOUP, Arnaud - EVANS, Edward W. - FACON, Benoit - GARDINER, Mary M. - GIL, Artur - GREZ, Audrey A. - GUILLEMAUD, Thomas - HAELEWATERS, Danny - HERZ, Anette - HONĚK, Alois - HOWE, Andrew Gordon - HUI, Cang - HUTCHISON, William D. - KENIS, Marc - KOCH, Robert L. - KULFAN, Ján - HANDLEY, Lori Lawson - LOMBAERT, Eric - LOOMANS, Antoon - LOSEY, John E. - LUKASHUK, Alexander O. - MAES, Dirk - MAGRO, Alexandra - MURRAY, Katie M. - SAN MARTIN, Gilles - MARTINKOVÁ, Zdenka - MINNAAR, Ingrid A. - NEDVĚD, Oldřich - ORLOVA-BIENKOWSKAJA, Marina - OSAWA, Naoya - RABITSCH, Wolfgang - RAVN, H. P. - RONDONI, Gabriele - RORKE, Steph L. - RYNDEVICH, Sergey K. - SAETHRE, May-Guri - SLOGGETT, John J. - SOARES, Antonio Onofre - STALS, Riaan - TINSLEY, Mathew C. - VANDEREYCKEN, Axel - VAN WIELINK, Paul S. - VIGLÁŠOVÁ, Sandra - ZACH, Peter - ZAKHAROV, Ilya A. - ZAVIEZO, Tania - ZHAO, Zihua. The harlequin ladybird, *Harmonia axyridis*: global perspectives on invasion history and ecology. In *Biological Invasions*, 2016, vol. 18, iss. 4, p. 997-1044. (2015: 2.855 - IF, Q1 - JCR, 1.462 - SJR, Q1 - SJR, Current Contents - CCC). (2016 - Current Contents). ISSN 1387-3547. Dostupné na: <https://doi.org/10.1007/s10530-016-1077-6>  
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ISBN 978-92-79-61751-5

Citacions: **39**

*Anton Krištín as one of the authors of the monograph published by IUCN by Publishing house of European commission is a member of the Grasshopper Specialist Group IUCN as an employee of IFE SAS and the monograph was created as part of his work at the IFE SAS. The affiliation of any of the authors of the monograph is not mentioned there.*

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Citations: **25**

**2.2.5. List of most-cited authors from the Institute (at most 10 % of average FTE researchers per year) and their number of citations in the assessment period (2015– 2020). The cited papers must bear the address of the institute**

1. Anton Krištín – 687 citations
2. Peter Zach – 362 citations
3. Peter Kaňuch – 347 citations
4. Ján Kulfan – 336 citations
5. Rastislav Jakuš – 318 citations

**2.2.6. List of most-cited authors from the Institute (at most 10 % of average FTE researchers per year) and their number of citations obtained until 2020. The cited papers must bear the address of the Institute**

1. Anton Krištín – 1 572 citations
2. Ján Kulfan – 681 citations
3. Peter Kaňuch – 644 citations
4. Peter Zach – 605 citations
5. Rastislav Jakuš – 459 citations

**2.2.7. List of most-cited authors from the Institute (at most 10 % of average FTE researchers per year) and their number of citations obtained until 2021 of their papers published during the evaluation period (2016– 2021). The cited papers must bear the address of the Institute**

1. Anton Krištín – 215 citations
2. Peter Zach – 211 citations
3. Ján Kulfan – 189 citations
4. Katarína Adamčíková – 153 citations
5. Ivan Mihál – 143 citations

## 2.3. Research status of the institute in international and national context

- **International/European position of the institute**

- 2.3.1. List of the most important research activities demonstrating the international relevance of the research performed by the institute, incl. major projects (details of projects should be supplied under Indicator 2.4). Max. 10 items for institute with less than 50 average FTE researchers per year, max. 20 for institutes with 50 – 100 average FTE researchers per year and so on**

During the assessment period the researchers from the institute were involved in:

### **Horizon 2020 Projects**

**SIMRA** – *Social Innovation in Marginalised Rural Areas*, H2020, no. 677622, start date: 04/2016, end date: 04/2020, WP Leader: T. Kluvánková; other collaborators from IFE SAS: S. Brnkaľáková, V. Gežík; Scientific Coordinator: James Hutton Institute, Scotland, <http://www.simra-h2020.eu/>

**INSPIRATION** – *Integrated Spatial Planning, Land Use and Soil Management Research Action*, H2020, no. 642372, start date: 04/2015, end date: 02/2018, Collaborators from IFE SAS: T. Kluvánková, S. Brnkaľáková, I. Štecová; Scientific Coordinator: Umweltbundesamt (UBA), Germany, <http://h2020.inspiration-agenda.eu/>

**eLTER** – *European Long-Term Ecosystem and socio-ecological Research Infrastructure*, H2020, no. 654359, start date: 06/2015, end date: 05/2019, Collaborator from IFE SAS: M. Barna, Scientific Coordinator: Umweltbundesamt GmbH, Austria, <https://www.lter-europe.net/>

### **ERASMUS+ Programme**

**ALIVE** – *Make Biology Fun with Virtual Reality*, Erasmus+, 2020-1-SK01-KA201-078297, start date: 11/2020, end date: 10/2022, Coordinator: IFE SAS, J. Kráľová; Other participants: University of Cyprus, Nicosia, Cyprus; České centrum odborného vzdělávání, z.o., Hodonín, Czech Republic, Institutou Technologias Ypologistinokai Ekdoseon Diofantos, Patras, Greece, Elementary School Benkova 34, Nitra, Slovakia; Consiglio Nazionale Delle Ricerche, Roma, Italy; <https://www.aliveproject.eu/>

### **European Interest Group (EIG) CONCERT-Japan**

**SMART-WaterDomain** – *Framework for Organisational Decision-Making Process in Water Reuse for Smart Cities*, EIG CONCERT-Japan/2019/881/SMART, start date: 04/2020, end date: 01/2024, Collaborator from IFE SAS: T. Kluvánková; Scientific Coordinator: Institute for Integrated Management of Material Fluxes and of Resources, United Nations University, Germany

### **Bilateral projects**

**SpaPopGen** – *Spatial analyses in population genetic studies of tree pathogens*, SK-FR-2017-0025, start date: 01/2018, end date: 12/2019, Coordinator: IFE SAS, K. Adamčíková, Partner institution: University of Bordeaux, French National Institute for Agricultural Research (INRA), BIOGECO, Cestas, France

**SEMIOS** – *The study of anti-attractant systems of native and invasive coniferous bark beetles in Euroasia*, SK-CN-2017-0041, start date: 01/2018, end date: 12/2019, Coordinator: IFE SAS, R. Jakuš, Partner institution: Institute of Zoology, Chinese Academy of Sciences, Beijing, China

## **COST projects**

**CLIMO** – *Climate Smart Forestry in Mountain Regions*, COST Action CA15226, start date: 10/2016, end date: 04/2021, WG4 Leader: T. Kluvánková, MC Member: L. Ditmarová, Coordinator: University of Molise, Italy, <https://www.cost.eu/actions/CA15226/>

**PINESTRENGTH** – *Pine pitch canker – strategies for management of Gibberella circinata in greenhouses and forests*, COST Action FP1406, start date: 05/2015, end date: 05/2019, Collaborator from IFE SAS: K. Adamčíková, Coordinator: General Foundation of the University of Valladolid, Spain, <https://www.cost.eu/actions/FP1406/>

**Global Warning** – *A global network of nurseries as early warning system against alien tree pests*, COST Action FP1401, start date: 12/2014, end date: 12/2018, Collaborator from IFE SAS: M. Barta, Coordinator: Commonwealth Agricultural Bureaux International (CABI), Switzerland, <https://www.cost.eu/actions/FP1401/>

### **2.3.2. List of international conferences (co)organised by the institute**

#### **International Congresses**

- II. European Congress on Orthoptera Conservation, 19-22 September 2018, Smolenice, Slovakia
- 2021 Bratislava Conference on Earth System Governance, 7-9 September 2021, Bratislava, Slovakia

#### **COST Meetings**

- International workshop on the COST-funded Innovations in Climate Governance (INOGOV) project, 2-3 June 2016, Bratislava, Slovakia
- Open international conference - Workshop and CLIMO meeting „Becoming climate-smart“, 9-11 September 2019, Stará Lesná, Slovakia

#### **Horizon Workshops**

- Workshop of H2020 project SIMRA (Social Innovation in Marginalised Rural Areas), 26-28 October 2016, Bratislava, Slovakia

#### **Czech-Slovak Conferences**

- Influence of abiotic and biotic stressors on properties of plants 2016, 12-14 September 2016, Zvolen, Slovakia
- X. Lepidopterological colloquium, 27 October 2016, Zvolen, Slovakia
- 28th Ornithological Conference “Applied Ornithology”, 8 September 2017, Zvolen, Slovakia
- Influence of abiotic and biotic stressors on properties of plants 2017, 12-14 September 2017, Prague, Czech Republic
- XVI Phyto-Apitherapeutical Days, 30 September - 1 October 2017, Košice, Slovakia
- VII Plant Health Days of Slovak Plant Health Society, 17-18 October 2017, Nitra, Slovakia
- 12th Teriological Conference “Research and Protection of Mammals in Slovakia”, 23-24 November 2017, Banská Bystrica, Slovakia
- Influence of abiotic and biotic stressors on properties of plants 2018, 4-6 September 2018, Zvolen, Slovakia
- Zoology Days 2019, 7-8 February 2019, Brno, Czech Republic
- Influence of abiotic and biotic stressors on properties of plants 2019, 3-5 September 2019, Prague, Czech Republic

- 30th Ornithological Conference “Applied Ornithology”, 13 September 2019, Zvolen, Slovakia
- VIII Plant Health Days of Slovak Plant Health Society, 15-16 October 2019, Nitra, Slovakia
- 14th Teriological Conference “Research and Protection of Mammals in Slovakia”, 14-15 November 2019, Banská Bystrica, Slovakia
- Zoology Days 2020, 6-7 February 2020, Olomouc, Czech Republic

### **2.3.3. List of edited proceedings from international scientific conferences**

- II. European Congress on Orthoptera Conservation: Book of Abstracts. Editors Anton Krištín, Peter Kaňuch, Axel Hochkirch. Zvolen: Institute of Forest Ecology SAS, 2018. 34 p. Available online at: <http://orthoptera.sk/2ndECOC/book-of-abstracts/index.html>. ISBN 978-80-89408-32-0

### **2.3.4. List of journals edited/published by the institute and information on their indexing in WOS, SCOPUS, other database or no database, incl. impact factor and other metrics of journals in each year of the assessment period**

#### ***Folia Oecologica* (ISSN 1336-5266)**

2016

Agris, CAB Abstracts, EBSCO hostTM databases, GEOBASE, SCOPUS, ProQuest databases

Scientific journal rankings: 0.17, SJR Best Quartile: Q4, H index: 8, Cites docs 2 years: 0.46, SNIP: 0.376, CiteScore 0.27, Percentile: 22, Percentile: 14

2017

AGRIS, Baidu Scholar, CABI (over 50 subsections), CNPIEC - cnpLINKer, EBSCO (relevant databases), EBSCO Discovery Service, Elsevier - SCOPUS, Google Scholar, J-Gate, Naviga (Softweco), Primo Central (ExLibris), ProQuest (relevant databases), Publons, ReadCube, Summon (Serials Solutions/ProQuest), TDNet, WanFang Data, WorldCat (OCLC)

Scientific journal rankings: 0.162, SJR Best Quartile: Q4, H index: 8, Cites docs 2 years: 0.19, SNIP: 0.211, CiteScore: 0.21, Percentile: 8

2018

AGRIS, Baidu Scholar, CABI (over 50 subsections), CNPIEC - cnpLINKer, DOAJ (Directory of Open Access Journals), EBSCO (relevant databases), EBSCO Discovery Service, Elsevier - SCOPUS, Elsevier - Engineering Village, Elsevier - Geobase, Elsevier – SCOPUS, Google Scholar, J-Gate, KESLI-NDSL (Korean National Discovery for Science Leaders), Naviga (Softweco), Primo Central (ExLibris), ProQuest (relevant databases), Publons, ReadCube, Summon (Serials Solutions/ProQuest), TDNet, WanFang Data, Web of Science - Biological Abstracts, Web of Science - Biosis Previews, Web of Science – Emerging Sources Citation Index, Web of Science - Zoological Record, WorldCat (OCLC)

Scientific journal rankings: 0.282, SJR Best Quartile: Q3, H index: 8, Cites docs 2 years: 0.62, SNIP: 0.511, CiteScore: 0.75, Percentile: 36

2019

AGRIS, Baidu Scholar, CABI (over 50 subsections), CNPIEC - cnpLINKer, DOAJ (Directory of Open Access Journals), EBSCO (relevant databases), EBSCO Discovery Service, Elsevier - SCOPUS, Elsevier - Engineering Village, Elsevier - Geobase, Elsevier – SCOPUS, Google Scholar, J-Gate, KESLI-NDSL (Korean National Discovery for Science Leaders), Naviga (Softweco), Primo Central (ExLibris), ProQuest (relevant databases), Publons, QOAM (Quality Open Access Market), ReadCube, Summon (Serials Solutions/ProQuest), TDNet, WanFang Data, Web of Science - Biological Abstracts, Web of Science - Biosis Previews, Web of Science - Emerging Sources Citation Index, Web of Science - Zoological Record, WorldCat (OCLC)



Scientific journal rankings: 0.274, SJR Best Quartile: Q2, H index: 9, Cites docs 2 years: 1.15, SNIP: 0.594, CiteScore: 1, Percentile: 28

2020

AGRICOLA (National Agricultural Library), AGRIS, Baidu Scholar, Biobase, Cabel's Whitelist, CABI (over 50 subsections), CNKI Scholar (China National Knowledge Infrastructure), CNPIEC – cnpLINKer, Dimensions, DOAJ (Directory of Open Access Journals), EBSCO (relevant databases), EBSCO Discovery Service, Engineering Village, Geobase, Google Scholar, J-Gate, JournalTOCs, KESLI-NDSL (Korean National Discovery for Science Leaders), MyScience Work, Naver Academic, Naviga (Softweco), Primo Central (ExLibris), ProQuest (relevant databases), Publons, QOAM (Quality Open Access Market), ReadCube, Semantic Scholar, SCOPUS, Summon (Serials Solutions/ProQuest), TDNet, WanFang Data, Web of Science - Biological Abstracts, Web of Science – Biosis Previews, Web of Science - Emerging Sources Citation Index, Web of Science - Zoological Record, WorldCat (OCLC)

Scientific journal rankings: 0.255, SJR Best Quartile: Q3, H index: 9, Cites docs 2 years: 1, SNIP: 0.64, CiteScore: 1.5, Percentile: 42

2021

AGRICOLA (National Agricultural Library), AGRIS, Baidu Scholar, Biobase, Cabel's Whitelist, CABI (over 50 subsections), CNKI Scholar (China National Knowledge Infrastructure), CNPIEC - cnpLINKer, Dimensions, DOAJ (Directory of Open Access Journals), EBSCO (relevant databases), EBSCO Discovery Service, Engineering Village, Geobase, GoOA, Google Scholar, J-Gate, JournalTOCs, KESLI-NDSL (Korean National Discovery for Science Leaders), MyScience Work, Naver Academic, Naviga (Softweco), Primo Central (ExLibris), ProQuest (relevant databases), Publons, QOAM (Quality Open Access Market), ReadCube, Semantic Scholar, SCOPUS, Summon (Serials Solutions/ProQuest), TDNet, WanFang Data, Web of Science - Biological Abstracts, Web of Science - Biosis reviews, Web of Science - Emerging Sources Citation Index, Web of Science - Zoological Record, WorldCat (OCLC)

Scientific journal rankings: 0.26, SJR Best Quartile: Q3, H index: 10, Cites docs 2 years: 1.463, SNIP: 0.706, CiteScore: 2.0, Percentile: 58

***Tichodroma*** (ISSN 1337-026X)

2016

Zoological Record, Recent Ornithological Literature, Ornithologische Schriftenschau

2017

Zoological Record, Recent Ornithological Literature, Ornithologische Schriftenschau

2018

Zoological Record, Recent Ornithological Literature, Ornithologische Schriftenschau

2019

SCOPUS, Zoological Record, Recent Ornithological Literature, Ornithologische Schriftenschau

2020

SCOPUS, Zoological Record, Recent Ornithological Literature, DOAJ (Directory of Open Access Journals)

Scientific journal rankings: 0.103, SJR Best Quartile: Q4

2021

SCOPUS, Zoological Record, Recent Ornithological Literature, DOAJ (Directory of Open Access Journals)

Scientific journal rankings: 0.140, SJR Best Quartile: Q4

- **National position of the institute**

### **2.3.5. List of selected activities of national importance**

#### **Scientific research cooperation with other research institutes of the SAS**

During the evaluation period, IFE SAS cooperated with the Botanical Institute CBRB SAS on the solution of 3 APVV projects (APVV-15-0210, K. Adamčíková; APVV-19-0134, M. Slezák; APVV-20-0257, K. Adamčíková) and 4 VEGA projects (2/0018/18, K. Adamčíková; 2/0016/19, M. Slezák; 2/0119/19, M. Slezák; 2/0108/21, M. Slezák).

IFE SAS cooperated with the Zoological Institute of SAS on solving 2 joint VEGA projects (2/0097/16, A. Krištín; 2/0065/20, A. Krištín).

Cooperation with the Institute of Informatics of the SAS is developing within an interdisciplinary project APVV-17-0116 *“Algorithm of collective intelligence: Interdisciplinary study of swarming behaviour in bats”* (P. Kaňuch).

In cooperation with the Institute of Geophysics of the SAS was solved the project VEGA 2/0089/14 entitled *“Flow deposition of acidifying components and ozone in the selected submountain and mountain areas of Slovakia”* (R. Janík)

Ecological relations in the host-parasitoid system are solved by IFE SAS in cooperation with the Institute of Landscape Ecology SAS within the solution of the project VEGA 2/0149/20 (Ľ. Černecká).

#### **Scientific research cooperation with universities**

IFE SAS has been cooperating for a long time with the Technical University in Zvolen (Faculty of Forestry, Faculty of Ecology and Environmental Studies) in pedagogical and scientific research activities. In the evaluation period, 6 APVV projects were solved in cooperation with Faculty of Forestry TUZVO (APVV-0135-12, Ľ. Ditmarová; APVV-0480-12, Ľ. Ditmarová; APVV-15-0425, R. Jakuš; APVV-16-0306, Ľ. Ditmarová; APVV-18-0347, R. Jakuš; APVV-18-0390, Ľ. Ditmarová) and 5 VEGA projects (1/0362/13, I. Mihál; 2/0034/14, Ľ. Ditmarová; 2/0077/17 P. Kaňuch; 2/0049/18, Ľ. Ditmarová; 1/0535/20, G. Jamnická); in cooperation with FEE TUZVO 1 project VEGA 2/0052/15 (P. Zach).

Scientific-research cooperation with the Faculty of Science, Comenius University in Bratislava, is focused on forest soil research in the Slovak Republic (E. Bublinec, J. Kukla, M. Kuklová) and arthropod research within joint projects VEGA 2/0035/13, 2/0012/17 and 2/0032/19. (J. Kulfan, P. Zach)

IFE SAS has a long-term contractual cooperation with the Faculty of Pharmacy, Comenius University in Bratislava, in the field of research of pharmacologically active substances in selected species of ornamental plants, within which it makes dendroexposures of the Mlyňany Arboretum available for experimental work. (P. Hoťka, J. Konôpková)

The project cooperation of IFE SAS with the University of Veterinary Medicine and Pharmacy in Košice was focused on microbiocenosis modulation of intestinal and immune response of honeybees using probiotic lactobacilli in a new dosage form (VEGA 1/0358/16) and the effect of application of honeybee autochthonous probiotic lactobacilli bound on the pollen carrier, on immune status and quality of honeybee products (VEGA 1/0505/19). (K. Bíliková)

IFE SAS, in cooperation with the Faculty of Science of UPJŠ in Košice, solved a joint project VEGA 2/0077/17 concerning the evolutionary ecology of umbrella and flag vertebrate species in Slovakia. The Faculty of Forestry of the Technical University in Zvolen also cooperated in solving the project. (P. Kaňuch)

In 2016, a joint workplace of the Faculty of Chemical and Food Technology STU Bratislava and IFE SAS Zvolen was established, between the Department of Molecular Apidology IFE SAS and the Institute of Biochemistry and Microbiology FCHTP STU and other departments of the faculty, including the Institute of Biotechnology and the Institute of Food and Nutrition. The departments

cooperated in the evaluation period in solving joint scientific projects APVV-14-0393 and APVV-16-0088.

In cooperation with the Slovak University of Agriculture in Nitra, the Department of Dendrobiology IFE SAS participates in educational activities at the Faculty of Agrobiography and Food Resources, the Faculty of Horticulture and Landscape Engineering and the Faculty of Biotechnology and Food Sciences, as well as in solving joint VEGA projects 2/0025/15 (M. Barta) and 2/0072/16 (J. Konôpková).

The Department of Strategic Environmental Analyses IFE SAS is a member of CE SPECTRA – the EU Center of Excellence - a joint workplace of the Slovak University of Technology, the Institute of Forest Ecology SAS and the Faculty of Management of Comenius University in Bratislava, which is located at the STU Rectorate. In addition to scientific activities, the SEA Department also comprehensively provides pedagogical activities (1<sup>st</sup> and 3<sup>rd</sup> degree studies). In the accreditation period, the joint workplace solved 3 VEGA projects 2/0038/14, 2/0013/17 and 2/0170/21. (T. Kluvánková)

SlovakGlobe (joint research centre of global changes at SAS and STU) was established in March 2019 on the basis of a memorandum between the Slovak Academy of Sciences and the Slovak University of Technology located at the STU Rectorate in Bratislava. SAS represents the Department of Strategic Environmental Analyses IFE SAS. SlovakGlobe focuses on finding new approaches to decision-making in conditions of uncertainty and complex choice, especially the role of social innovations or the theory of shared goods in addressing the societal challenges of global change in the social aspects of global change and low-carbon economics from the point of view of economic sectors. (T. Kluvánková)

IFE SAS cooperates in the areas of scientific research and educational activities (leadership and training of bachelor's and master's degree students) with the Faculty of Natural Sciences UCM in Trnava. (E. Ondrušková)

The Department of Plant Pathology and Mycology of IFE SAS cooperates with the Faculty of Natural Sciences UKF in Nitra in the areas of scientific research, educational and scientific-popularization activities, including contractual cooperation of students' professional practice, 3<sup>rd</sup> and 5<sup>th</sup> year of the study field Biology - scientific field. The Department of Dendrobiology cooperates with FPV UKF in Nitra in teaching (conducting laboratory exercises, bachelor's and master's theses, opposing bachelor's and master's theses, field semester exercises), joint project cooperation (VEGA 2/0058/18), co-organizing professional and scientific events.

The Mlyňany Arboretum woody species collections are used for educational activities in all types of schools. University students with a focus on biology, ecology, horticulture and forestry completed field and semester exercises, professional practice and solved their final theses in the evaluation period (2016-2021) in the Mlyňany Arboretum. Elementary and high school students completed excursions on the educational trails of the arboretum focused on learning about trees and building environmental feelings. They completed a non-traditional teaching process of science subjects, prepared for different age groups of elementary school students in the computer classroom "World of Trees" and in "Creative Workshops".

### **Cooperation with institutions outside SAS and Universities**

During the evaluation period IFE SAS cooperated with the National Forestry Centre in Zvolen on 6 APVV projects (APVV-14-0567, P. Zach; APVV-15-0348, J. Kulfan; APVV-16-0031, M. Barta; APVV-16-0344, M. Kuklová; APVV-19-0116, M. Barta; APVV-19-0119, J. Kulfan).

Scientific-research cooperation with the Soil Science and Conservation Research Institute in Bratislava is focused on research of forest soils in Slovakia. (E. Bublinec, J. Kukla, M. Kuklová)

### **Expertise and other professional activities**

The Department of Plant Pathology and Mycology evaluates the stability of woody plants by acoustic tomography using the Fakopp 3D device (Fakopp Bt., Republic of Hungary) and prepares proposals for measures to reduce the risk of woody plants, prevent endangering property and public health. In the evaluation period (2016-2021), a total of 145 contracts were implemented for local governments, business entities, as well as private individuals.

Consulting - identification of harmful organisms in forest stands, ornamental and private greenery and proposal of protective measures (the Department of Plant Pathology and Mycology, the Department of Animal Research and Ecological Interactions).

Expertise for the State Nature Protection of the Slovak Republic in Banská Bystrica in 2018 - Assessment of the impact of human activities (forestry, tourist activities, etc.) on the populations of critically endangered species of black grouse bird species (Eurasian capercaillie and Black grouse) in the Low Tatras National Park and Muránska planina within the "Expert working group for Eurasian capercaillie and Black grouse" established by the Ministry of the Environment of the Slovak Republic (M. Saniga).

Expert consultations for employees of the State Nature Protection of the Slovak Republic concerning the monitoring and protection of protected insect species (the Department of Animal Research and Ecological Interactions).

Long-term research of forest development in the Tatra National Park after wind and bark-beetle calamities. For the TANAP Administration and the TANAP State Forests, the IFE SAS annually provides data on the occurrence and abundance of Scolytinae beetles in selected areas of the Tatras (P. Zach, J. Kulfan, M. Saniga). Data on the occurrence of leaf-eating caterpillars in oaks were provided for Plášťovce Forest Administration (J. Kulfan).

Ecological counseling through the mass media - identification of plants and animals for the public, explaining the behavior of animals, or human-animal interactions: radio and television programs (M. Saniga).

Professional advice in the field of mycology - mushroom counseling for the public (I. Mihál).

Expert advice in the field of apidology and practical use of bee products (K. Bíliková).

#### **2.3.6. List of journals (published only in the Slovak language) edited/published by the institute and information on their indexing in WOS, SCOPUS, other database or no database, incl. impact factor and other metrics of journals in each year of the assessment period**

N/A

#### **• Position of individual researchers in the international context**

##### **2.3.7. List of invited/keynote presentations at international conferences, as documented by programme or invitation letter**

HNILIČKA, F., KUKLOVÁ, M., HNILIČKOVÁ, H., KUKLA, J.: Využití spalné kalorimetrie ve vztahu rostlina-půda-atmosféra [Use of combustion calorimetry in the relationship of plant - soil - atmosphere]. In: 38th International Czech and Slovak Calorimetry Seminar, 23-27 May 2016, Luhačovice, Czech Republic. Oral presentation

KRIŠTÍN, A., HOI, H., VALERA, F., BARNER, J.: Every Lesser grey shrike is considered: Human impact on habitat, breeding and abundance after 25 years. In: Ornithological Conference „Every Bird Counts“, 14-16 October 2016, Mikulov, Czech Republic. Oral presentation

KRIŠTÍN, A., JARČUŠKA, B., KAŇUCH, P.: Distributional patterns of *Poecilimon schmidtii* at its northern range margin with remarks on status of Orthoptera species in Slovakia In: First Hungarian Orthoptera Conference 2016, 17 September 2016, National Museum Budapest, Hungary. Oral presentation

BÍLIKOVÁ, K., PENG, CH., YAMAGUCHI, K., MUDROŇOVÁ, D.: Potential application of honey bee antimicrobial peptides in human and veterinary medicine. In: 11th Central and Eastern European Proteomic Conference, 27-29 September 2017, Košice, Slovakia. Oral presentation

JAKUŠ, R.: Management of bark beetle outbreaks and related disturbances in protected areas: focus on the Šumava National Park. In: Managing bark beetle outbreak in Białowieża Primeval Forest, 4 December 2017, Warszawa, Poland. Oral presentation

KLUVÁNKOVÁ, T.: What is social innovation? In: DG Agri Workshop - How can social innovations contribute to rural development? 5 December 2017, Brusel, Belgium. Oral presentation

KONÔPKOVÁ, J., HOŤKA, P., BOŠIAKOVÁ, D., FERUS, P.: Dreviny Arboréta Mlyňany a možnosti ich rozmnožovania [Woody plants in Mlyňany Arboretum and ways of their propagation]. In: Influence of abiotic and biotic stressors on properties of plants, 13-14 September 2017, Prague, Czech Republic. Oral presentation

KRIŠTÍN, A.: Life strategies in endangered species: case study of Lesser Grey Shrike *Lanius minor*. In: Ornithological Conference of the Czech Ornithological Society, 1-2 December 2017, Brno, Czech Republic. Oral presentation

KRIŠTÍN, A., HARVANČÍK, S.: Birds of prey in Slovakia: distribution, abundance and conservation. In: International conference „Peregrines in urban environment“, 11-12 March 2017, Recklingshausen, Germany. Oral presentation

MEZEI, P.: Population dynamics of spruce bark beetle (*Ips typographus*) in National Parks: observations and analysis. In: Managing bark beetle outbreak in Białowieża Primeval Forest, 4 December 2017, Warszawa, Poland. Oral presentation

BÍLIKOVÁ, K., YAMAGUCHI, Y.: Molecular characterization of propolis and royal jelly components as a tool for the study of their multifunctional therapeutic effects. In: 2nd International Conference on Propolis in Human and Bee Health, 28-29 September 2018, Sofia, Bulgaria. Oral presentation

JAKUŠ, R., TURČÁNI, M., MODLINGER, R., SUROVÝ, P., JIROŠOVÁ, A., TOMÁŠKOVÁ, I., BLAŽENEC, M., GURTSEV, A., UNELIUS, R., SCHLYTER, R.: Conceptualization and preliminary results on a semiochemical based bark beetle management under climate stress, project EXTEMIT-K, for the Eurasian spruce beetle in Europe. In: 2018 ESA, ESC and ESBC Joint Annual Meeting: Crossing Borders: Entomology in a Changing World, 11-14 November 2018, Vancouver, BC, Canada. Oral presentation

KLUVÁNKOVÁ, T., GEŽÍK, V.: Writing your first academic paper, Writing process and technique. In: Slovak Economic Association Meeting, 21-22 September 2018, Bratislava, Slovakia. Oral presentation

KOBZA, M., OSTROVSKÝ, R.: Arboriculture in Slovakia. In: V. Faápoló konferencia, 15 February 2018, Bükfürdő, Hungary. Oral presentation

KRIŠTÍN, A.: Conflict human versus animals: Problems of global change? In: Humboldt Kolleg, 20-22 September 2019, Piešťany, Slovakia. Oral presentation

ŠIMÚTH, J., YAMAGUCHI, Y., BÍLIKOVÁ, K.: Gelee Royale: Neue Trends in der molekularen Forschung und Anwendung in der Apitherapie [Royal jelly: New trends in molecular research and application in apitherapy]. In: 17th German Apitherapy Congress, 29-31 March 2019, Passau, Germany. Oral presentation

#### **2.3.8. List of researchers who served as members of the organising and/or programme committees**

RNDr. Katarína Bíliková, PhD.  
Mgr. Stanislava Brnkaľáková, PhD.  
Mgr. Ľudmila Černecká, PhD.  
RNDr. Ľubica Ditmarová, PhD.  
Mgr. Martina Dorková  
Ing. Gabriela Jamnická, PhD.



Ing. Benjamín Jarčuška, PhD.  
 Ing. Miriam Kádasi-Horáková, PhD.  
 Mgr. Peter Kaňuch, PhD.  
 prof. Mgr. Tatiana Kluvánková, PhD.  
 Mgr. Marek Kobza, PhD.  
 RNDr. Anton Krištín, DrSc  
 Ing. Ján Kukla, CSc.  
 Ing. Margita Kuklová, CSc.  
 RNDr. Ján Kulfan, CSc.  
 RNDr. Ivan Mihál, CSc.  
 Mgr. Ladislav Naďo, PhD.  
 Ing. Radovan Ostrovský, PhD.

### 2.3.9. List of researchers who received an international scientific award

Mgr. Viera Baštáková  
 Ing. Eva Pšidová, PhD.  
 doc. Ing. Miroslav Saniga, CSc.

- **Position of individual researchers in the national context**

#### 2.3.10. List of invited/keynote presentations at national conferences, as documented by programme or invitation letter

KRIŠTÍN, A.: Životné stratégie ohrozeného druhu s túlavými topánkami: príbeh druhu *Lanius minor* [Life strategies of an endangered species with stray shoes: the story of *Lanius minor*]. In: 3rd scientific congress Zoology 2016, 24-26 November 2016, Nitra. Oral presentation

BARNA, M., BOŠEĽA, M., KONÔPKA, B.: Uhlíkový režim v bučinách s rôznymi postupmi hospodárenia (Ekologický Experimentálny Stacionár) [Carbon storage regime in beech forest under different management (Ecological Experimental Station)]. In: From allometric relations to production-ecological research of forest vegetation, Scientific Workshop, 23 May 2017, Zvolen. Oral presentation

DITMAROVÁ, Ľ., BLAŽENEC, M.: Aktuálne priority a perspektívy výskumu na Ústave ekológie lesa SAV [Current research priorities and perspectives at the Institute of Forest Ecology SAS]. In: Long-term ecological research and monitoring of forests - current knowledge and challenges for the future, 7-8 November 2017, Zvolen. Oral presentation

KLUVÁNKOVÁ, T.: SIMRA - príklady úspešných projektov s účasťou slovenských partnerov [SIMRA - examples of successful projects with the participation of Slovak partners]. In: National Information Day - Horizon 2020 SC2, 7 November 2017, Lužianky. Oral presentation

BÍLIKOVÁ, K., YAMAGUCHI, Y.: Antimikrobiálny potenciál včelstva využiteľný v apiterapii [Antimicrobial potential of bee colonies usable in apitherapy]. In: XVII Phyto-Apitherapeutical Days, 21-22 September 2019, Košice. Oral presentation

KRIŠTÍN, A., BALÁZS, C., BALÁZS, A.: Biogeograficky a ekosoologicky významné živočíšne druhy CHKO Cerová vrchovina [Biogeographically and ecosoologically important animal species of the Cerová vrchovina Protected Landscape Area]. In: Conference on the 30th anniversary of the Cerová vrchovina Protected Landscape Area declaration, 3 October 2019, Číž. Oral presentation

MICHALKO, J.: Skrytý svet rastlín. Vzťahy medzi rastlinami a mikroorganizmami [The hidden world of plants. Relationships between plants and microorganisms]. In: Viva la Science Summer School, 28 August 2019, Nitra. Oral presentation

ŠIMÚTH, J., KOŠLÍK, S., BÍLIKOVÁ, K., YAMAGUCHI, Y.: Nové molekulárne dôkazy o liečivých účinkoch včelieho peľu [New molecular evidence on the healing effects of bee pollen]. In: XVII Phyto-Apitherapeutical Days, 21-22 September 2019, Košice. Oral presentation

KULFAN, J., ZACH, P., SARVAŠOVÁ, L., PARÁK, M., SANIGA, M., MIKUŠ, M., ZÚBRIK, M.:  
Piadivka jesenná a ďalšie zimné piadivky v našich dubinách: môžeme očakávať zmeny?  
[*Operophtera brumata* and other winter geometrid moths in our oak forests: can we expect  
changes?] In: 29th international conference Actual Problems in Forest Protection 2020, 23-24  
January 2020, Horný Smokovec. Oral presentation

#### **2.3.11. List of researchers who served as members of organising and programme committees of national conferences**

RNDr. Katarína Bíliková, PhD.  
Ing. Marek Barta, PhD.  
RNDr. Dominika Bošiaková  
Ing. Peter Ferus, PhD.  
Ing. Angela Filová, PhD.  
Ing. Miriam Kádasi-Horáková, PhD.  
Mgr. Marek Kobza, PhD.  
Ing. Jana Konôpková, PhD.  
Ing. Emília Ondrušková, PhD.  
Ing. Radovan Ostrovský, PhD.  
Mgr. Katarína Pastirčáková, PhD.  
Ing. Jozef Pažitný, PhD.

#### **2.3.12. List of researchers who received a national scientific award**

Mgr. Viera Baštáková  
RNDr. Katarína Bíliková, PhD.  
Mgr. Ľudmila Černecká, PhD.  
RNDr. Anton Krištín, DrSc.  
Ing. Margita Kuklová, CSc.  
RNDr. Ján Kulfan, CSc.  
Ing. Eva Pšidová, PhD.  
doc. Ing. Miroslav Saniga, CSc.  
Ing. Katarína Sládeková  
Ing. Jozef Váľka, CSc.  
Ing. Sandra Viglášová

## 2.4. Research grants and other funding resources

(List type of project, title, grant number, duration, total funding and funding for the institute, responsible person in the institute and his/her status in the project, e.g. coordinator “C”, work package leader “W”, investigator “I”. Add information on the projects which are interdisciplinary, and also on the joint projects with several participating SAS institutes)

- **International projects**

### 2.4.1. List of major projects of Framework Programmes of the EU (which pillar), NATO, COST, etc.

Project title	Type / Project number	Duration	Funding for the Institute (EUR)	Role of the Institute / Responsible person
Integrated Spatial Planning, land use and soil management Research Action	H2020 / 642372	04/2015-02/2018	2016: 3 500 2017: 3 150 2018: 747	I / Tatiana Kluvánková
Social Innovation in Marginalised Rural Areas	H2020 / 677622	04/2016-04/2020	2016: 28 481 2017: 69 270 2018: 76 223 2019: 63 270 2020: 42 251	W / Tatiana Kluvánková
European Long-Term Ecosystem and socio-ecological Research Infrastructure	H2020 / 654359	06/2015-06/2019	2016: 0 2017: 776 2018: 0 2019: 0	I / Milan Barna
ALIVE – Make Biology Fun with Virtual Reality	Erasmus+ / 2020-1-SK01-KA201-078297	11/2020-10/2022	2020: 15 120 2021: 15 120	C / Jarmila Králová
Payments for Ecosystem Services (Forests for Water)	COST / CA15206	10/2016-10/2020	2016: 875 2017: 3 150 2018: 4 480 2019: 3 797 2020: 2 867	I / Tatiana Kluvánková
Climate Smart Forestry in Mountain Regions	COST / CA15226	10/2016-10/2020	2016: 875 2017: 3 532 2018: 2 240 2019: 2 500 2020: 2 083	I / Ľubica Ditmarová
Climate Smart Forestry in Mountain Regions	COST / CA15226	10/2016-04/2021	2016: 0 2017: 2 906 2018: 2 240 2019: 1 297 2020: 2 867 2021: 1 435	I / Tatiana Kluvánková
EuroXanth: Integrating science on Xanthomonadaceae for integrated plant disease management in Europe	COST / CA16107	04/2019-03/2021	2019: 2 848 2020: 3 440 2021: 718	I / Jaroslav Michalko
Knowledge conversion for enhancing management of European riparian ecosystems and services	COST / CA16208	11/2017-05/2022	2017: 0 2018: 5 227 2019: 3 797 2020: 3 440 2021: 2 631	I / Michal Slezák

Climate change and bats: from science to conservation	COST / CA18107	02/2019-02/2023	2019: 3 481 2020: 3 440 2021: 2 870	I / Peter Kaňuch
Understanding and exploiting the impacts of low pH on micro-organisms	COST / CA18113	04/2019-04/2023	2019: 2 848 2020: 3 440 2021: 2 870	I / Jaroslav Michalko
Biodiversity of temperate forest taxa orienting management sustainability by unifying perspectives	COST / CA18207	11/2019-11/2023	2019: 633 2020: 3 440 2021: 2 870	I / Peter Ferus
New approaches in detection of pathogens and aeroallergens	COST / CA18226	07/2019-11/2023	2019: 1 899 2020: 3 440 2021: 2 870	I / Jaroslav Michalko
European Soil-Biology Data Warehouse for Soil Protection	COST / CA18237	07/2019-09/2023	2019: 1 899 2020: 3 440 2021: 2 870	I / Jaroslav Michalko
Pan-European Network for Climate Adaptive Forest Restoration and Reforestation	COST / CA19128	10/2020-10/2024	2020: 2 293 2021: 2 870	I / Peter Ferus
European venom network	COST / CA19144	10/2020-10/2024	2020: 0 2021: 3 348	I / Ľudmila Černecká
Enhancing the resilience capacity of sensitive mountain forest ecosystems under environmental change	COST / ES1203	07/2013-06/2016	2016: 3 208	I / Jozef Váľka
Using three-way interactions between plants, microbes and arthropods to enhance crop protection and production	COST / FA1405	03/2015-03/2019	2016: 3 500 2017: 3 150 2018: 4 480 2019: 949	I / Jaroslav Michalko
Fraxinus dieback in Europe: elaborating guidelines and strategies for sustainable management	COST / FP1103	04/2012-04/2016	2016: 1 167	I / Katarína Adamčíková
Studying Tree Responses to Extreme Events: a Synthesis	COST / FP1106	04/2012-04/2016	2016: 1 167	I / Ľubica Ditmarová
Forest Land Ownership Changes in Europe: Significance for Management And Policy	COST / FP1201	11/2012-11/2016	2016: 3 208	I / Tatiana Kluvánková
A global network of nurseries as early warning system against alien tree pests (Global Warning)	COST / FP1401	06/2015-12/2018	2016: 3 500 2017: 3 150 2018: 4 480	I / Marek Barta
Pine pitch canker - strategies for management of Gibberella circinata in greenhouses and forests	COST / FP1406	05/2015-05/2019	2016: 3 500 2017: 3 150 2018: 4 480 2019: 1 582	I / Katarína Adamčíková
Network for Sustainable Ultrascale Computing	COST / ICT1309	11/2013-11/2017	2016: 3 500 2017: 3 150	I / Urban Kováč
Tourism, Wellbeing and Ecosystem Services	COST / IS1204	09/2013-08/2016	2016: 2 917	I / Veronika Gežík
Innovations in Climate Governance: Sources, Patterns and Effects	COST / IS1309	06/2014-06/2018	2016: 3 500 2017: 3 150 2018: 0	I / Tatiana Kluvánková

European Information System for Alien Species	COST / TD1209	04/2014-12/2016	2016: 3 500	I / Peter Ferus
European Information System for Alien Species	COST / TD1209	05/2013-05/2017	2016: 3 500 2017: 1 313	I / Peter Zach

### **Add information on your activities in international networks**

Other important international projects and collaborations without direct funding:

#### Multilateral projects

*Arthropod communities in fungal fruitbodies*, Coordinator: Stifterverband für die Deutsche Wissenschaft, Germany, Partner institutions: Department of Ecology - Animal Ecology, Faculty of Biology, Philipps-Universität Marburg, Marburg, Germany, Institute of Forest Ecology SAS, Collaborator from IFE SAS: A. Krištín, start date: 01/2016, end date: 12/2021

*Distribution of some animal groups in Madagascar: effect of habitat quality and altitude*, Partner institutions: National Museum, Prague, Czech Republic; University of Antananarivo, Madagascar; University Hamburg, Germany; Institute of Forest Ecology SAS, Forest Research Institute, University of Matej Bel, Slovakia; Collaborator from IFE SAS: A. Krištín, start date: 04/2015, end date: 12/2022

*Methods of analysis immune status of honeybee using hemolymph markers*, Partner institutions: Laboratoire AGIM UJF CNRS France; Institute du Liebfeld Agroscope, Berne, Suisse; Institute of Forest Ecology SAS, Slovakia; Collaborator from IFE SAS: K. Bíliková, start date: 09/2013, end date: 08/2016

#### European Regional Development Fund

*Centre of the investigation of synthesis and transformation of nutritional substances in food chain in interaction with potentially risk substances of anthropogenic origin*, European Regional Development Fund (ERDF), CZ.02.1.01/0.0/0.0/16\_019/0000845, Coordinator: Faculty of Agrobiolgy, Food and Natural Resources CZU, Czech Republic, Collaborator from IFE SAS: M. Kuklová, start date: 11/2018, end date: 12/2022

#### Collaboration agreements

*Analysis of revitalization process in beech ecosystems over the immission load*, Agreement between IFE SAS and Institute of Botany of the Czech Academy of Sciences, Czech Republic, Collaborator from IFE SAS: M. Barna, start date: 01/2018, end date: 12/2021

*Changes in the number and activity of soil microorganisms during black locust invasion*, Agreement between IFE SAS and Institute of Plant Physiology and Genetics, National Academy of Sciences of Ukraine, Collaborator from IFE SAS: P. Ferus, start date: 0/2017, end date: 12/2019

*Influence of abiotic and biotic stresses on properties of plants*, Agreement between IFE SAS and Faculty of Agrobiolgy, Food and Natural Resources CZU, Czech Republic, Collaborator from IFE SAS: M. Kuklová, start date: 11/2016, end date: 11/2026

*International soil biogeography consortium for biodiversity studies and conservatorium of soil communities (iSBio Consortium)*, Coordinator: Leipzig University, German Center for Integrative Biodiversity Research, Germany, Collaborator from IFE SAS: M. Barna, start date: 07/2018, end date: 09/2024

*Ornithologische Schriftensschau*, Agreement between IFE SAS and Deutsche ornithologische Gesellschaft, Germany, Collaborator from IFE SAS: A. Krištín, start date: 01/2003, end date: 12/2019

*Structure, health status and regeneration capability of dendrocoenoses destructed by wind invasion in Rila – Rodopi massif, Vitosha Mt and Low and High Tatras Mts*, Agreement between IFE SAS and Forest Research Institute of the Bulgarian Academy of Sciences, Bulgaria, Collaborator from IFE SAS: I. Mihál, start date: 01/2015, end date: 12/2017



Above mentioned international networks, agreements and cooperation enhanced also the quality of scientific activities of research teams at the Institute of Forest Ecology SAS.

Many of these activities in international networks are reflexed in important and highly cited publications in impacted journals like Science, Nature, etc.

Some selected examples:

## **2017**

Reciprocal working stays of researchers at foreign universities in Cambridge and Oxford in Great Britain (P. Zach) and IFE SAS (P.M.J. Brown) with a focus on research of foreign invasive insect species resulted in a publication in the journal *BioControl* (2017). In order to study the chemical ecology of invasive species of *Ambrosia* beetles, a research stay of an internal doctoral student of the Institute in the United States Department of Agriculture, Agricultural Research Service, Horticultural Insects Laboratory, Application Technology Research Unit, Wooster, Ohio, USA, was carried out (M. Dzurenko).

The SEA department has successfully used the possibilities of MVTs through mobilities. Within the SIMRA H2020 and CLIMO Cost Action 15226 projects, the STSM research stay took place at the Icelandic Forest Research and National Forests and Afforestation Programs in Iceland (S. Brnkaľáková) and at the summer school in Budapest (V. Bašťáková, I. Štecová and A. Kaiser). They presented topics: "System incentives for the support of cultural ecosystem services in climate change adaptation", and "Urban ecosystem services in climate change mitigation. As part of the Cost Action PESFOR-W project, a stay at the University of Copenhagen took place in order to develop the theory and methodology in the field of motivation for payments for ecosystem services (V. Bašťáková).

## **2018**

As part of the bilateral project SK-FR-2017-0025 (Spatial analyses in genetic-population studies of fungal pathogens of woody plants), a stay was held with the co-research organization INRA Bordeaux (Adamčíková & Jánošíková). The relationships between genetic (haplotypes, clusters) and spatial data for the parasitic fungus *Dothistroma septosporum* were analyzed, the suitability of selected approaches and analyses and the possibilities of how to best present the data were discussed.

## **2019**

The Climate Smart Project (COST Action CA15226) Climate Smart Forestry in Mountain Regions (CLIMO) is a Horizon 2020 network project under the COST scheme in 27 European countries, including Slovakia. The main objectives of the project are in particular: to define Climate-Smart Forestry, to test the operating conditions in selected experimental areas in Europe's mountain forests, to create a European smart network for climate smart forestry (ESFONET), to develop innovative payment schemes for ecosystem services (PES), and to analyze the requirements needed to develop a website containing data directly from experimental sites. CLIMO consists of four working groups. The Institute of Forest Ecology SAS participates in the solution of all working groups – including the team of Plant Ecophysiology (Ditmarová L. et al.) and the team of Strategic Environmental Analyses (Kľuvánková T. et al.), which also provides the project management of the working group WG4: Innovative payment schemes for ecosystem services. The result of working activities within 4 working groups is a methodology defining "Climate-Smart Forestry - CSF" and the preparation of a monograph on the topic.

## **2020**

K. Adamčíková (Department of Plant Pathology and Mycology, IFE SAS) participated in a meeting of Euphresco 2016-G-223 project researchers entitled *Lecanosticta* -Brown spot disease of pines-spread in European forest ecosystems: impact on pines, predisposing and contributing factors, control (BROWNSPOTRISK), organized by the Estonian University of Life Sciences. The leaders of the individual working groups presented the state of fulfilment of the set goals, the details for the preparation of the geodatabase of *L. acicola* findings were reached, and the representatives of some participating countries presented new results of their research. The researcher's active participation was also in the Euphresco 2019-A-316 project entitled "Early detection of *Phytophthora* in EU and third country nurseries and traded plants".

The plant ecophysiology team of IFE SAS contributed to the activities of the COST action CA15226 (CLIMO) also through a scientific publication in the international journal *Photosynthetica* (2020). The publication deals with the evaluation of the efficiency and effectiveness of photosystems II (PSII) in five Central European provenances of Silver fir (*Abies alba*), which differ in origin (250 to 1300 m above sea level). The study used the methodology of OJIP curves and parameters derived from JIP tests. The results confirmed that Silver fir is generally resistant to water scarcity (mild to moderate drought stress) at the level of PSII photosystems, but differences in photochemistry were found between provenances from different climatic conditions, where provenances from higher altitudes (from wetter and colder localities) achieved higher PSII efficiencies, which was also supported by clear trends along climatic and geographical gradients of provenance origin. L. Ditmarová and G. Jamnická participated in the preparation of a monograph focused on climate-intelligent forestry in the conditions of mountain forests in Europe within the COST action "CLIMO".

The SIMRA project ended in March 2020. The working reports on: Deliverable D.2.3: Operationalization of stakeholder engagement: a guide, which summarizes the process of involving all stakeholder groups in the SIMRA project, were finalized and thus fulfilled the project's original transdisciplinary methodology to support societal challenges and creation of scientific knowledge with the active participation of societal actors (Task 2.3) and journal articles (*Sustainability*; *Sociologia Ruralis*) were finalized, especially on the typology of spreading social innovations in marginalized rural regions as a strategy for adapting and transforming society towards a sustainable economy and climate protection. A thematic issue of the journal *Environmental Policy and Governance* entitled "Social innovations for sustainable governance of nature" is also being prepared (Klůvanková T. et al.).

In 2021, as part of the **MVTS CLIMO** project, the IFE SAS team participated in writing chapters in the book "Climate-Smart Forestry in Mountain Regions". Part of this book is Chapter 2 entitled "Defining climate-smart forestry" (co-authors L. Ditmarová and G. Jamnická). The team of the SEA department (S. Brnkaľáková, T. Klůvanková) participated in Chapter 12 "Economic and social perspective of climate-smart forestry: incentives for behavioral change to climate-smart practices in the long term". The same team also participated in an extensive study of mapping institutional models to support the sustainable management of ecosystem services in European forests (Primmer et al. 2021 (co-author T. Klůvanková): Mapping Europe's institutional landscape for forest ecosystem service provision, innovation and governance. In: *Ecosystem Services*, 47, article no. 101225). A documentary film was also released as part of the CLIMO project (also performed by T. Klůvanková). This video presents the CLIMO project (2016 - 2021), which brought together scientists from 28 European and neighbouring countries to address challenges and advance understanding and actions in response to a rapidly changing environment.

video: <https://www.youtube.com/watch?v=qouZ-AUavIQ>

web link: <https://www.cetip-network.eu/en/post/CLIMO-movie-ziVQz6>

Within the MVTS, since 2014 the institute has had very good cooperation with the Department of Botany and Plant Physiology of the Czech University of Life Sciences in Prague (M. Kuklová, I. Pivková). In 2021, international cooperation resulted in joint activities focusing on the study of the content of risk elements in soils and plants and their impact on plant physiology in the air pollution field of exhalation sources Slovmag Lubeňík and the preparation of a publication (M. Kuklová et al: Anthropogenic effects on risk elements accumulation in soils and plants from dust deposition of magnesium factory).

As part of the long-term cooperation of the staff of IFE SAS and the Czech University of Agriculture on the mapping of European birds, a monograph was published in 2021 in the Czech and Slovak mutation "Birds of the Czech Republic and Slovakia", summarizing trends in abundance and distribution, as well as the ecology and acoustics of this group of animals (Křišťín A. & Šťastný K.).

- **National projects, incl. international projects with only national funding**

#### **2.4.2. List of ERA-NET projects funded from SAS budget**

N/A

#### **2.4.3. List of projects of the Slovak Research and Development Agency, APVV**

<b>Project title</b>	<b>Project number</b>	<b>Duration</b>	<b>Funding for the Institute (EUR)</b>	<b>Role of the Institute / Responsible person</b>
Adaptive genetic potential of forest tree populations in the context of climate changes	APVV-0135-12	10/2013-09/2017	2016: 21 196 2017: 17 159	I / Ľubica Ditmarová
The study of bark beetle infestation spreading mechanism in spruce forests	APVV-0297-12	10/2013-09/2017	2016: 59 739 2017: 49 018	C / Miroslav Blaženec
Nutrient-energy cycles as disturbance indicators of terrestrial ecosystems	APVV-0480-12	10/2013-09/2017	2016: 13 391 2017: 9 811	I / Ľubica Ditmarová
Complex utilization of bark extractives	APVV-14-0393	07/2015-06/2019	2016: 6 044 2017: 6 044 2018: 6 044 2019: 2 096	I / Jozef Váľka
Information and warning system for invasive organisms in forest and urban environments	APVV-14-0567	07/2015-06/2018	2016: 26 102 2017: 26 226 2018: 12 203	I / Peter Zach
* Distribution potential of different fungal trophic groups in Europe	APVV-15-0210	07/2016-06/2020	2016: 7 014 2017: 14 297 2018: 9 817 2019: 11 024 2020: 2 846	I / Katarína Adamčíková
New methods in an integrated forest protection incorporating the use of entomopathogenic fungi	APVV-15-0348	07/2016-06/2019	2016: 16 644 2017: 33 406 2018: 33 282 2019: 16 668	I / Ján Kulfan
Impact of natural hazards on forest ecosystems in Slovakia under conditions of future climate	APVV-15-0425	07/2016-06/2019	2016: 11 705 2017: 22 557 2018: 22 563 2019: 11 460	I / Rastislav Jakuš
The study of spruce - bark beetles interactions - new possibilities of semiochemicals use	APVV-15-0761	07/2016-06/2020	2016: 27 602 2017: 52 795 2018: 73 098 2019: 68 416 2020: 27 900	C / Rastislav Jakuš
Research of alternative methods of conifer seedlings protection against insect pests	APVV-16-0031	07/2017-12/2020	2017: 843 2018: 5 000 2019: 5 000 2020: 2 500	I / Marek Barta
Complex utilization of plant biomass in biofoods with added value	APVV-16-0088	07/2017-06/2021	2017: 4 180 2018: 9 429 2019: 10 904 2020: 9 679 2021: 4 810	I / Jozef Váľka

Identification of environmental vulnerability and adaptive potential of Norway spruce ( <i>Picea abies</i> Karst. L.) populations under changing climate	APVV-16-0306	07/2017-06/2021	2017: 5 299 2018: 33 226 2019: 40 749 2020: 29 999 2021: 11 607	C / Ľubica Ditmarová
Energy potential of primary production of the above-ground dendromass of forest stands	APVV-16-0344	07/2017-06/2021	2017: 5 253 2018: 7 483 2019: 7 370 2020: 7 495 2021: 4 749	I / Margita Kuklová
<b>* Algorithm of collective intelligence: Interdisciplinary study of swarming behaviour in bats</b>	<b>APVV-17-0116</b>	08/2018-07/2022	2018: 13 213 2019: 29 678 2020: 27 366 2021: 24 553	C / Peter Kaňuch
Climate change and natural hazards impacts: vulnerability and adaptive capacity of Western Carpatians forest ecosystems	APVV-18-0347	07/2019-06/2022	2019: 10 602 2020: 21 204 2021: 22 516	I / Rastislav Jakuš
Growth and production of mountain ecosystems under conditions of climate aridization	APVV-18-0390	07/2019-06/2023	2019: 7 695 2020: 11 398 2021: 21 088	I / Ľubica Ditmarová
Application of entomopathogenic fungi from the genus <i>Beauveria</i> against invasive insect species	APVV-19-0116	07/2020-12/2022	2020: 10 123 2021: 20 059	I / Marek Barta
The potential for fungus <i>Entomophaga maimaiga</i> to regulate gypsy moth <i>Lymantria dispar</i> (L.) in Slovakia	APVV-19-0119	07/2020-12/2022	2020: 14 758 2021: 28 776	I / Ján Kulfan
<b>* Aliens among us: Spatio-temporal dynamics of plant invasions and their adverse impact on ecosystems</b>	APVV-19-0134	07/2020-06/2024	2020: 393 2021: 2 462	I / Michal Slezák
Norway spruce response to acute stress in relation to bark beetle attack	APVV-19-0606	07/2020-12/2023	2020: 64 734 2021: 69 319	C / Miroslav Blaženec
<b>* Tree and country – influence of trees on diversity of soil microorganisms in agricultural land</b>	APVV-20-0257	07/2021-06/2025	2021: 3 075	I / Katarína Adamčíková
The study of anti-attractant systems of native and invasive coniferous bark beetles in Euroasia)	SK-CN-2017-0041	01/2018-12/2019	2018: 1 688 2019: 1 808	C / Rastislav Jakuš
Spatial analyses in population genetic studies of tree pathogens	SK-FR-2017-0025	01/2018-12/2019	2018: 1 045 2019: 1 028	C / Katarína Adamčíková

Interdisciplinary projects indicated in bold.

\* Joint project with several participating SAS institutes

#### 2.4.4. List of projects of the Scientific Grant Agency of the Slovak Academy of Sciences and the Ministry of Education, VEGA (for funding specify only total sum obtained from all VEGA grants in particular year)

VEGA	2016	2017	2018	2019	2020	2021
Number	18	21	21	22	23	19
Funding in the year (EUR)	143 815	151 886	136 316	129 384	120 627	90 237

#### 2.4.5. List of projects supported by EU Structural Funds

N/A

#### 2.4.6. List of other projects funded from national resources

Project title	Type / Project number	Duration	Funding for the Institute (EUR)	Role of the Institute / Responsible person
Framework for Organisational Decision-Making Process in Water Reuse for Smart Cities	EIG CONCERT-Japan / 2019/881/SMART-	04/2020-01/2024	2020: 8 140 2021: 16 250	W / Tatiana Kluvánková
Physiological parameters of social groups of tree-dwelling bats associated with swarming behaviour	DoktoGrant / APP0148	01/2021-12/2021	2021: 2 000	C / Romana Ružinská

#### 2.4.7. List of projects funded from private funds

Project title	Type / Project number	Duration	Funding for the Institute (EUR)	Role of the Institute / Responsible person
Monitoring of the physiological potential of royal jelly based on new scientific knowledge)	JRP / 20180387	01/2019-03/2021	2019: 30 554 2020: 33 442 2021: 1 324	C / Katarína Bíliková
Molecular and physiological properties of honeybee royal jelly proteins	JRP / 242020	04/2014-03/2020	2016: 20 000 2017: 20 000 2018: 24 480 2019: 16 484 2020: 860	C / Katarína Bíliková

#### 2.4.8. List of projects funded from other competitive funds

N/A

### 2.5. PhD studies and educational activities

#### 2.5.1. List of accredited programmes of doctoral studies, period of validity, source of funding

From 2006 up to 31.12.2019: **Field of study:** General ecology and ecology of individuals and populations. The guarantor at IFE SAS is RNDr. Anton Krištín, DrSc.

Since 1.1.2020 continuing as: **Field of study:** Ecological and environmental sciences, **Study programme:** Ecology and biodiversity conservation. The guarantor of the field of study at IFE SAS is RNDr. Anton Krištín, DrSc.

Since 18.8.2020 is accredited also the second **Field of study:** Forestry; **Study programmes:** Forest Ecology, Forestry Phytology. The guarantor at IFE SAS is Ing. Peter Zach, PhD.



**2.5.2. Summary table on doctoral studies (number of internal/external PhD students at the end of the year; number of foreign PhD students, number of students who successfully completed their theses during the year, number of PhD students who quit the programme during the year)**

PhD study	2016			2017			2018			2019			2020			2021		
Number of potential PhD supervisors																		
PhD students	number, end of year	defended thesis	students quitted	number, end of year	defended thesis	students quitted	number, end of year	defended thesis	students quitted	number, end of year	defended thesis	students quitted	number, end of year	defended thesis	students quitted	number, end of year	defended thesis	students quitted
Internal total	9	2	0	7	5	0	5	2	1	5	1	1	6	1	0	6	0	3
from which foreign citizens																		
External																		
Other supervised by the research employees of the institute	6	1	1	5	2	2	4	2	2	2	1	2	2	1	2	4	0	0

**2.5.3. PhD carrier path – Information on the next career steps of the PhD graduates who received their degree from the institute**

Altogether 11 PhD students defended their thesis within 2016-2021, of them nine remained in the academic positions at the Universities or Academy, four of them at our institute (Sarvašová 2016, Majdák, Kubov 2017, Černecká 2018).

**2.5.4. Summary table on educational activities**

Teaching	2016	2017	2018	2019	2020	2021
Lectures (hours/year)*	338	418	494	279	191	215
Practicum courses (hours/year)*	660	339	376	300	336	171
Supervised diploma and bachelor thesis (in total)	26	22	23	26	23	15
Members in PhD committees (in total)	4	6	3	5	5	2
Members in DrSc. committees (in total)	1	1	1	1	0	1
Members in university/faculty councils (in total)	5	5	4	4	5	5
Members in habilitation/inauguration committees (in total)	1	1	1	1	2	3

### 2.5.5. List of published university textbooks

BARNA, Milan - BUBLINEC, Eduard. Základy všeobecnej ekológie [Essentials of ecology]. Reviewers Ivan Vološčuk, Slavomír Stašiov. 1<sup>st</sup> Edition. Ružomberok : Verbum, 2016. 129 p. ISBN 978-80-561-0351-7

*Milan Barna as one of the authors of this university textbook is an employee of IFE SAS, while the textbook was created as part of his VEGA project 2/0039/14 (listed in the publication).*

RAŽNÁ, Katarína - BEŽO, M. - ŽIAROVSKÁ, Jana - ŠTEFÚNOVÁ, Veronika - FILOVÁ, Angela - GAJDOŠOVÁ, Alena - OSTROLUCKÁ, Mária-Gabriela - HRICOVÁ, Andrea - LIBIAKOVÁ, Gabriela. Reviewers Ľ. Ďurišová, J. Konôpková. 1<sup>st</sup> Edition. Nitra: Slovak University of Agriculture, 2018. 151 p. ISBN 978-80-552-1860-1.

### 2.5.6. Number of published academic course books

MOTYLEVA, Svetlana - OSTROVSKÝ, Radovan - HORČINOVÁ SEDLÁČKOVÁ, Vladimíra - BRINDZA, Ján. Charakteristika peľu a včelích peľových obnôžok z vybraných druhov rastlín [Characterization of pollen and bee pollen of selected plant species]. In BRINDZA, Ján et al. *Peľ a včelie peľové obnôžky z niektorých druhov rastlín : učebné texty pre špecializované kurzy v medzinárodnom projekte*. 1<sup>st</sup> Edition. - Nitra : Slovak University of Agriculture in Nitra, 2018, p. 53-105. ISBN 978-80-552-1862-5.

### 2.5.7. List of joint research laboratories/facilities with universities

**The Laboratory of Molecular Apidology** – a joint research unit of the Institute of Forest Ecology at the Slovak Technical University in Bratislava (2016 – 2020)

**SlovakGlobe** – a joint research centre of Slovak Academy of Sciences – Institute of Forest Ecology and the Slovak University of Technology (was formed in 2019). This centre concerns interdisciplinary research on management of global change mainly in following areas:

- Managing global change for societal transition to sustainability
- Behavioral change and knowledge co-production

### 2.5.8. Supplementary information and/or comments on doctoral studies and educational activities – focused on what changes have occurred since the last evaluation in 2016

The Institute applies own criteria for supervisors and PhD students allowing the inclusion of best researchers and PhD candidates into doctoral studies. Such criteria increasing the overall quality of a doctoral study were not adopted during the previous accreditation period.

Based on the agreement with the Faculty of Forestry of the Technical University in Zvolen, the Institute has been providing a PhD (doctoral) study in the field Forestry since August 2020.

Between 2016 and 2021 the tutors at the Institute supported their PhD students more actively than previously with regard to performing research in universities and institutes abroad. Examples are participations of PhD students in international mobility projects, i.e. COST (S. Viglášová – three Short Time Scientific Missions at the K Centre for Ecology and Hydrology, UK), The National Fellowship Program of Ministry of Education, Science, Research and Sport of the Slovak Republic (M. Dzurenko - United States Department of Agriculture, USA, H. Hudokova – University of Novi Sad, Serbia)

Four PhD students of the Institute (M. Havašová - Potterf, L. Naďo, Ľ. Černecká, P. Mezei) were allowed to continue their research after a defence their PhD studies through a prestigious support of the *Schwarz Fund of the Slovak Academy of Sciences*. This kind of funding is highly regarded at the national level.

One PhD student (R. Ružinská) obtained research grants for young researchers in the category “doctogrants” provided by the Slovak Academy of Sciences recently.

**True story: M. Havašová - Potterf (nice example a successful career of young scientist)**



The Institute provided support and research facilities for bachelor and diploma students from universities in Sweden, France:

**Matilda Jützeler**, Sveriges Lantbruksuniversitet i Uppsala, Sverige (27.3. - 30.5.2019 at IFE SAS): Polyandry and genetic diversity in populations of *Pholidoptera griseoptera* along an environmental gradient (Bachelor thesis, 2019)

**Clémence Boivin**, Université Catholique de l'Ouest – Angers, France (8.3. - 11.6.2021 at IFE SAS): The giant noctule *Nyctalus lasiopterus*, an umbrella species in the Carpathian forest in Central Slovakia (Master thesis, 2021)

Motivation of university graduates to conduct their doctoral studies has been generally decreasing in changing socio-economic conditions in Slovakia. Finding a motivated PhD student in ecology and forestry is much more difficult than over the previous accreditation period. Hence, our present strategy is more oriented for recruitment of PhD students from international environment.

## 2.6. Societal impact

**2.6.1. The most important case studies of the research with direct societal impact, max. 4 for institute with up to 50 average FTE researchers per year, 8 for institutes with 50 – 100 average FTE researchers per year and so on. Structure: Summary of the impact; Underpinning research; References to the research; Details of the impact; Sources to corroborate the impact. One page per one case study**

### Analysis of the relationship between protected areas with the non-interventional regime and the neighbouring spruce stands decline

#### Submitting Institution

Institute of Forest Ecology, Slovak Academy of Sciences

#### Unit of Assessment

Spruce forest ecosystems

#### Summary Impact Type

Environmental, Economic

#### Research Subject Area(s)

*Ecology*: Environment protection, Nature conservation; *Forestry*: Forest protection

## Summary of the impact

In 2004, a large area of spruce ecosystems belonging also to national parks and nature reserves non-interventional regime (PA) was damaged by wind disturbance and a subsequent bark beetles outbreak. After this, a long-running dispute between organizations under the jurisdiction of the Ministry of Agriculture and Rural Development of the Slovak Republic (State Enterprise Forests of the Slovak Republic, forest owners) and the Ministry of Environment of the Slovak Republic (The State Nature Conservancy of the Slovak Republic) started. The dispute was whether the unprocessed calamity in the PA constantly serves as a source of bark beetle spreading to the surrounding managed forests. At the suggestion of the State Nature Conservancy of the Slovak Republic, we prepared an analysis to determine whether the disturbance was earlier in the nature reserves or the surrounding area, whether it could serve as a source of bark beetles for spreading in the surrounding forest stands, or whether the calamity around the nature reserve is not growing due to insufficient management by forest users. The result of the analysis strengthened the negotiating position of State nature conservancy in the dispute over forcing a change in the management regime in the PAs (from non-interventional to managing of wind and bark beetle disturbances) or the payment of compensation for forest damage in the vicinity of the PA.

## Underpinning research

Based on a time series of classified Landsat images between 2000 and 2017, we analyzed 117 PAs with spruce and their surroundings in buffers 100, 500, 1000 and 2000 m. Damage was identified in 93% PA and 100% adjacent buffers. The onset of disturbance was demonstrably in PA at 7.7% in one or more surrounding buffers in 61.5%, and the rest was indeterminate. The highest share of damage occurred in 8 PA, 23 in the buffer zone of 100 m, 26 both in the buffer zones 500 and 1000 m, and 34 in the buffer zone 2000 m.

## References to the research

[Analýza vzťahu medzi chránenými územiaми s bezzásahovým režimom a rozpadom smrekových porastov v ich okolí](#) [Analysis of the relationship between protected areas with the non-interventional regime and the neighbouring spruce stands decline]

**Contact:** Institute of Forest Ecology of Slovak Academy of Sciences, Department of Disturbance Ecology, L. Štúra 2, 96001 Zvolen, SLOVAKIA, <https://ife.sk/>

## Tree stability evaluation with use of acoustic tomography

### Submitting Institution

Institute of Forest Ecology, Slovak Academy of Sciences

### Unit of Assessment

Urban Environment

### Summary Impact Type

Environmental, Economic

### Research Subject Area(s)

*Ecology:* Environment protection, *Agriculture:* Plant protection, *Physics:* Acoustic tomography

## Summary of the impact

The use of precision equipment able to determine inner state of tree trunks and evaluation of health state of trees in urban environment resulted in higher precision and unbiased result of expertise. Beside skill and experiences of operators, cavities or decay in trees are very often difficult to determine only by visual inspection. Therefore, due to safety reasons, trees with structural defects are being felled to maintain safety of residents. The use of acoustic tomograph lead the potential risk of tree failure to be more objectively evaluated and consequently the appropriate measures taken to maintain or increase safety of tree. Out of the research it has been proved that acoustic tomography method provides sufficient level of precision. As a direct outcome, trees after evaluation and

subsequent necessary measures taken remains safe for residents, and as addition saved trees, not necessary to be felled down, remain on-place and plays role in healthier urban environment. Yearly income for Institute is up to 15.000 €, with continuously increasing demand for expertise every year (average of 250 trees per year).

### **Underpinning research**

In 2017, Dr. R. Ostrovský and Dr. M. Kobza, both scientists at Institute of Forest Ecology of Slovak Academy of Sciences, published paper demonstrating that acoustic tomography is reliable and of high precision while used on trees in urban environment. Out of five tree species evaluated, the range of internal damage determined by acoustic tomograph compared to visual evaluation of such damage after tree felling reached 90%. Total accuracy determination for both area and location of damage was 83%.

### **References to the research**

OSTROVSKÝ, Radovan - KOBZA, Marek - GAŽO, Ján. Extensively damaged trees tested with acoustic tomography considering tree stability in urban greenery. In *Trees*, 2017, vol. 31, no. 3, p. 1015-1023. ISSN 0931-1890. <https://link.springer.com/article/10.1007/s00468-017-1526-6>

**Contact:** Institute of Forest Ecology of Slovak Academy of Sciences, Department of Plant Pathology & Mycology Nitra, Akademická 2, 949 01 Nitra, SLOVAKIA, <https://ife.sk/>

## **Biological control of bark beetles with entomopathogenic fungi**

### **Submitting Institution**

Institute of Forest Ecology, Slovak Academy of Sciences

### **Unit of Assessment**

Forest Environment

### **Summary Impact Type**

Environmental, Economic

### **Research Subject Area(s)**

*Forestry*: biological control

### **Summary of the impact**

Joint research of Scientica s.r.o., Institute of Zoology, Institute of Forest Ecology, Polymer Institute, and State Forests of TANAP into searching for ecological and effective measures how to control outbreaks of spruce bark beetle (*Ips typographus*) in Tatra National Park has led to the development of biocontrol strategy. The strategy is based on the propagation and release of inoculum of the natural bark beetle antagonist, *Beuveria bassiana*, into forests by means of modified pheromone traps.

*Ips typographus* is the most destructive bark beetle of conifer forests which is capable of killing healthy and vigorous trees as soon as its population exceeds critical levels. In Slovakia, the massive outbreak and establishment of new foci have been triggered by the windstorm 'Alžbeta' in 2004 and repeated windstorms during the last decade. The consequent bark beetle outbreaks were considered the most severe in the recorded history of Slovakia. To check these outbreaks, we focused on the strategy of biocontrol using insect parasitic fungi which are naturally present antagonists in insect populations at low prevalence levels. A highly virulent strain of *B. bassiana* was selected for biocontrol of bark beetles and was effective in semifield conditions. The strain is also the subject of the Slovak patent SK 288591 B6. Inoculum of the strain is aimed to be combined with modified pheromone traps for its effective dissemination into bark beetle populations and thus bioregulation of this pest. The research has a direct environmental impact because biological control has the potential to replace treatments with chemical insecticides and thus reduce contamination of forests with pesticides. The economic impact is also important because the spruce bark beetle is the most destructive insect pest of conifer forests in Slovakia causing significant timber loss every year.



## Underpinning research

The application of *B. bassiana* against bark beetles is not a novel idea. Many studies that applied *B. bassiana* either by spraying conidia on trap logs or by combining powdery conidia formulations with pheromone traps, showed no satisfactory outcomes in field conditions. In our research, we went beyond the selection of a virulent strain and also searched for an appropriate application form of the fungus. The inoculum of selected strain was propagated under controlled conditions and immobilized into the low-molecular polyethylene matrix that was developed for this particular purpose by Polymer Institute. The matrix had no adverse effects on the infectivity of the inoculum and even increased its viability in field conditions. The inoculum formulated into the polyethylene matrix was combined with modified pheromone traps and tested in semi-field conditions.

## References to the research

BARTA, M. - KAUTMANOVÁ, I. - ČIČKOVÁ, H. - FERENČÍK, J. - FLORIÁN, Š. - NOVOTNÝ, J. - KOZÁNEK, M. Hypocrealean fungi associated with populations of *Ips typographus* in West Carpathians and selection of local *Beauveria* strains for effective bark beetle control. In *Biologia*, 2018, vol. 73, no. 1, p. 53-65.

BARTA, M. - KAUTMANOVÁ, I. - ČIČKOVÁ, H. - FERENČÍK, J. - FLORIÁN, Š. - NOVOTNÝ, J. - KOZÁNEK, M. The potential of *Beauveria bassiana* inoculum formulated into a polymeric matrix for a microbial control of spruce bark beetle. In *Biocontrol Science and Technology*, 2018, vol. 28, no. 7, p. 718-735.

**Contact:** Institute of Forest Ecology of Slovak Academy of Sciences, Department of Plant Pathology & Mycology Nitra, Akademická 2, 949 01 Nitra, SLOVAKIA, <https://ife.sk/>

## Development of an electronic application for recording occurrence of ladybirds within Europe: a tool for citizen science

### Submitting Institutions

International cooperation of the Institute of Forest Ecology, Slovak Academy of Sciences, Zvolen, Slovakia, with the UK Centre for Ecology and Hydrology, Wallingford, United Kingdom (project and ladybird survey leader); Crop Research Institute, Prague, Czechia; Applied Ecology Research Group, School of Life Sciences, Anglia Ruskin University, Cambridge, United Kingdom; Flumens Ltd., Wallingford, United Kingdom; Department of Biology, University of Florence, Florence, Italy; Centre for Ecology, Evolution and Environmental Changes and Azorean Biodiversity Group, Faculty of Sciences and Technology, University of the Azores, Ponta Delgada, Portugal; Research Institute for Nature and Forest, Geraardsbergen, Belgium; Biology Center of Czech Academy of Sciences, Institute of Entomology, České Budějovice; Faculty of Science, University of South Bohemia, České Budějovice, Czechia

### Unit of Assessment

Terrestrial ecosystems and habitats within Europe

### Summary Impact Type

Biodiversity conservation at the international level

### Research Subject Areas

Ecology and nature Conservation: Ladybirds and insect conservation, Habitat and environmental conservation; Physics: Smartphone application

### Summary of the impact

Citizen science initiatives are increasingly used in the wildlife observations and research nowadays. Charismatic and popular ladybirds include many species that are relatively easy to identify from photographs. They are therefore appropriate insects for engaging people through citizen science initiatives to contribute long-term and large-scale datasets. As a result of cooperation of nine research institutions from the United Kingdom, Czech Republic, Slovakia, Italy, Belgium and Portugal

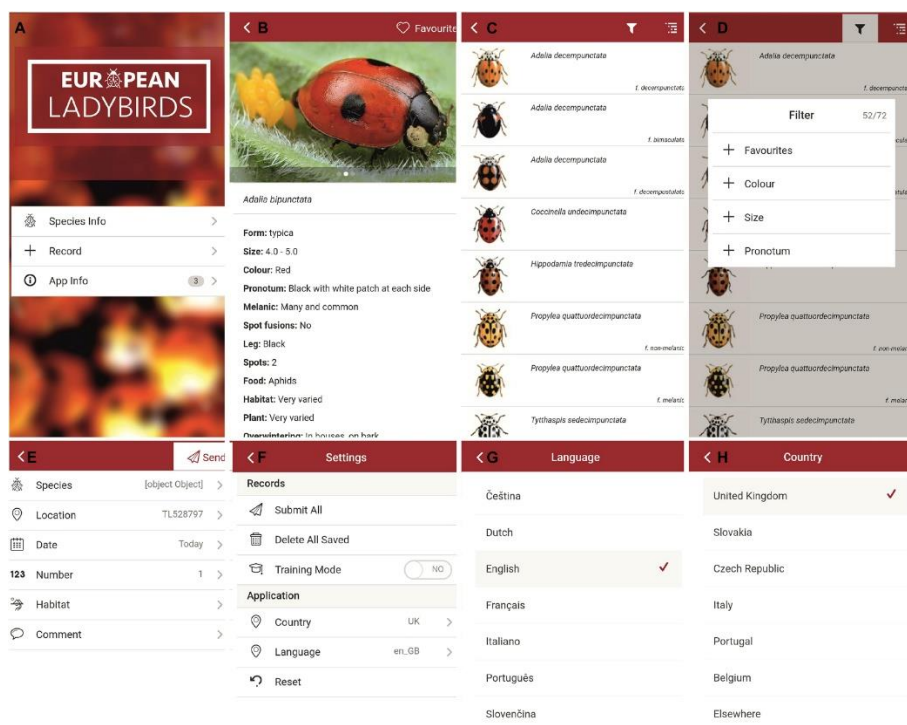
a mobile application for ladybird recording and identification across Europe (The European Ladybird Survey) has been developed. The application is to compile distribution data for ladybird species throughout Europe over time and increase awareness of the public about importance of ladybirds. In the application ladybird species were assessed on the basis of their prominent external characters and probability of occurrence within each country. This enables users to reduce the number of species to only those with relevance to the location of the recorder. The application is amongst the first collaborative citizen science approaches aimed at involving participants across Europe in recording a group of insects. It is aimed to be expanded to all countries in Europe.

## References to the research

SKUHROVEC, Jiří - ROY, Helen E. - BROWN, Peter M. J. - KAZLAUSKIS, Karolis - INGHILESI, Alberto - SOARES, Alberto O. - ADRIAENS, Tim - ROY, David B. - NEDVĚD, Oldřich - ZACH, Peter - VIGLÁŠOVÁ, Sandra - KULFAN, Ján - HONĚK, Alois - MARTINKOVÁ, Zdenka. Development of the European ladybirds smartphone application: A tool for citizen science. In *Frontiers in Ecology and Evolution*, 2021, vol. 9, p. 1-8. (2020: 4.171 - IF, Q1 - JCR, 1.317 - SJR, Q1 - SJR). ISSN 2296-701X. <https://doi.org/10.3389/fevo.2021.741854>

## Contact in Slovakia

Institute of Forest Ecology of Slovak Academy of Sciences, Department for Animal and Ecological Interactions, L. Štúra 2, 960 01 Zvolen, Slovakia



## The power of social innovation to steer sustainable governance of nature

### Submitting Institution

Department of Strategic Environmental Analyses - SlovakGlobe, Institute of Forest Ecology, SAS

### Unit of Assessment

Forest, Marginalised rural areas

### Summary Impact Type

Environmental - Economic - Social

## Research Subject Area(s)

*Social innovation development, societal transformation, knowledge co-production, climate governance*

## Summary of the impact

Defining social innovation as “the reconfiguring of social practices, in response to societal challenges, targeting at well-being improvement and engagement of civil society actors” (SIMRA project [www.simra-h2020.eu](http://www.simra-h2020.eu)) has risen potential to promote civic values and foster transformation changes associated with the steering of sustainable development and promoting a more sustainable governance of nature. The European Union has provided an essential leverage capacity for social innovation (European Green Deal, Agenda 2030, EU Programme for Employment and Social Innovation) meaning to deliver support to rural development, especially when and where markets and existing public institutions fail.

At first, social innovation has been conceptualised (Klúvanková et al., 2018), embed into systematic processes of socio-ecological changes and activated through theoretical and expert knowledge exchange. Specifically, developed multi-dimensional transdisciplinary approaches enabled researchers to bring together a set of actors (representing businesses, academia, governments and civil society, including local communities across study areas) to participate on activities of VELL lab to study behavioural change to sustainability. Interaction of stakeholders and science lab in two-way collaborative learning processes enabled co-production of solutions to challenges faced by people and nature with the formulation of recommendations for relevant EU, regional and national policies. Secondly, the concept of diverging development paths for social innovation development (Klúvanková et al., 2021) and potential use in other locations has been modelled with the use of rich empirical material (211 validated social innovation examples and 11 in-depth cases from the H2020 SIMRA research project). Deductive analyses resulted in the creation of a typology of social innovations, with four development divergent paths identified as most probable to success in sustainability transformation resulting in changes of EU marginalised rural areas in order to turn such areas' diversity into strengths.

## Underpinning research

*Between 2016-2020 SEA team lead Work package 2 of project SIMRA titled: Theoretical and operational frameworks to understand social innovations in rural areas.*

*Impact of Social Innovation on sustainable development of rural areas* was presented in the article Klúvanková et al, 2018 in special issues of [Forest Policy and Economics](#) journal.

Article *Social innovation for sustainability transformation and its diverging development paths in marginalised rural areas* published in [Sociologia Ruralis](#) in 2021 has been awarded as most cited article of the Journal for 2020-21, already a year after publishing!

The role of social innovation in steering the development of disadvantaged communities towards more prosperous futures through their more sustainable governance of nature already accepted as special issue of [Environmental Policy and Governance](#) coedited by prof. Klúvanková and with 3 forthcoming contributions by SEA team.

Findings of the work under SIMRA project are part of strategic planning of the EU to design and revise rural EU policy and in particular for EU Green deal implementation and has been presented at several policy forums organised by DG Regio and Horizon 2020 (<https://ife.sk/> [www.cetip-network-eu](http://www.cetip-network-eu)).

## References to the research

KLUVÁNKOVÁ, Tatiana - NIJNIK, Maria - ŠPAČEK, Martin - SARKKI, Simo - PERLIK, Manfred - LUKESCH, Robert - MELNYKOVYCH, Mariana - VALERO, Diana - BRNKALÁKOVÁ, Stanislava\*\*. Social innovation for sustainability transformation and its diverging development paths in marginalised rural areas. In *Sociologia ruralis*, 2021, vol. 61, iss. 2, p. 344-371. (2020: 2.812 - IF, Q2 - JCR, 1.005 - SJR, Q1 - SJR, - CCC). (2021 - Current Contents). ISSN 0038-0199. na: <https://doi.org/10.1111/soru.12337>

KLUVÁNKOVÁ, Tatiana - BRNKALÁKOVÁ, Stanislava\*\* - ŠPAČEK, Martin - SLEE, Bill - NIJNIK, Maria - VALERO, Diana - MILLER, David - BRYCE, Rosalind - KOZOVÁ, Mária - POLMAN, Nico - SZABO, Tomáš - GEŽÍK, Veronika. Understanding social innovation for the well-being of forest-dependent communities: A preliminary theoretical framework. In Forest Policy and Economics, 2018, vol. 97, p. 163-174. (2017: 2.496 - IF, Q1 - JCR, 1.010 - SJR, Q1 - SJR, - CCC). (2018 - Current Contents). ISSN 1389-9341. <https://doi.org/10.1016/j.forpol.2018.09.016>

**Contact:** Institute of Forest Ecology of Slovak Academy of Sciences, Department of Strategic Environmental Analyses - SlovakGlobe, Vazovova 5, Bratislava, phone: +421 908 902 394, email: [kluvankova@ife.sk](mailto:kluvankova@ife.sk), Slovakia, <https://ife.sk/>

**2.6.2. List of the most important studies and/or other activities commissioned for the decision-making authorities, the government and NGOs, international and foreign institutes (title, name of institution, contract value, purpose (max 20 words))**

N/A

**2.6.3. List of contracts and research projects with industrial and other commercial partners, incl. revenues (study title, name of institution, contract value, country of partner, purpose (max 20 words))**

N/A

**2.6.4.1 List of intangible fixed assets (internally registered IP (confidential know-how), patent applications, patents granted, trademarks registered) denoting background IPR**

N/A

**2.6.4.2 List of licences sold abroad and in Slovakia, incl. revenues (background IPR identification, name of institution, contract value, country of partner, purpose (max 20 words))**

N/A

**2.6.5. Summary of relevant activities, max. 300 words (describe the pipeline of valorization in terms of Number of disclosure, Number of registered IP internally, number of CCR/LIC contracts and their respective summary values, the support you are receiving in specific points internally at the institute, at SAS, externally – also the limitations and drawbacks.**

N/A

## **2.7. Popularisation of Science (outreach activities)**

### **2.7.1. List of the most important popularisation activities, max. 20 items**

#### **Books and articles in press/internet**

SANIGA, Miroslav. A Year in Nature [Rok v prírode]. 1st edition, Bratislava: Perfekt, 2016, 224 p. ISBN: 978-80-8046-687-9.

KRIŠTÍN, Anton. Low-temperature adaptation of birds and other animals in Slovakia [Adaptácie vtáctva a ďalších živočíchov na nízke teploty na Slovensku]. Weekly newspaper entitled My Zvolenské noviny, 17.1.2017.

KULFAN, Ján – SARVAŠOVÁ, Lenka – PARÁK, Michal – DZURENKO, Marek – ZACH, Peter. Can late-blooming trees in temperate forests avoid caterpillar attack? [Môžu sa neskoro pučiace stromy v lesoch mierneho pásma vyhnúť útoku húseníc?]. Internet medium Veda na dosah, 5.7.2018, <http://vedanadosah.cvtisr.sk/mozu-sa-neskoro-puciace-stromy-v-lesoch-mierneho-pasma-vyhnut-utoku-husenec>

SANIGA, Miroslav. Walks through Slovak nature [Prechádzky slovenskou prírodou]. 1st edition, Bratislava: AlleGro Plus, 2019, 265 p. ISBN: 978-80-973087-7-3.

JAMNICKÁ, Gabriela. Conifers declining enormously. SAS News, 29.12.2020. [https://www.sav.sk/?lang=en&doc=services-news&source\\_no=20&news\\_no=9268](https://www.sav.sk/?lang=en&doc=services-news&source_no=20&news_no=9268)

KLUVÁNKOVÁ, Tatiana. Climate Smart Forestry in Mountain Regions. Documentary video on EU COST Action project CLIMO. 15.4.2021. <https://www.youtube.com/watch?v=gouZ-AUavIQ>

#### **Appearances in telecommunication media**

Public-service institution Radio and Television Slovakia (RTVS) – programme RTVS News [Správy RTVS]. Drought wreaks havoc on rare plants [Sucho robí problémy vzácnym rastlinám], 3.7.2016. HOŤKA, Peter – FERUS, Peter.

Public-service institution – private radio station Rádio Lumen – programme Farmers' Club [Farmársky klub]. On research and the positive effects of royal jelly on human health [O výskume a pozitívnych účinkoch včelej materskej kašičky na ľudské zdravie], 23.10.2017. BÍLIKOVÁ, Katarína – ŠIMÚTH, Jozef.

Public-service institution Radio and Television Slovakia (RTVS) – programme RTVS Morning News [RTVS Ranné správy]. The importance of bird migration and global climate change [Význam migrácií vtáctva a globálna zmena klímy], 5.4.2018. KRIŠTÍN, Anton.

On-line HN Television. A genetic study estimated the number of bears in Slovakia [Genetická štúdia odhadla počet medvedov na Slovensku], 21.12.2019, KRIŠTÍN, Anton. <https://slovensko.hnonline.sk/2061876-geneticka-studia-odhadla-kolko-medvedov-je-na-slovensku-ich-pocty-rastu>

Public-service institution Radio and Television Slovakia (RTVS) – programme RTVS News [Správy RTVS], live stream. People are threatened by old trees [Staré stromy ohrozujú ľudí], 7.10.2019. KOBZA, Marek – OSTROVSKÝ, Radovan – ADAMČÍKOVÁ, Katarína.

Private television channel TV Markíza – programme Television news [Televízne noviny]. Bird diseases: papillomatosis and others [Choroby vtáctva: papilomatózy a iné], 14.5.2021. KRIŠTÍN, Anton.

Public-service institution Radio and Television Slovakia (RTVS) – television station STV 2 – programme Regína. Bird conservation [Ochrana vtáctva], 16.3.2021. SANIGA, Miroslav.



## Public popularisation lectures

Sex conflict: an evolutionary tele-novel from the life of insects [Súboj pohlaví: evolučná tele-novela zo života hmyzu]. Public lecture at the Festival of Science Researchers' Night in Slovakia 2016 [Festival vedy Noc výskumníkov na Slovensku 2016], 30.9.2016. KAŇUCH, Peter.

Madagascar expedition: landscape, nature, people [Expedícia Madagaskar: krajina, príroda, ľudia]. Public lecture, Upper-Nitra Museum, Prievidza, 10.1.2017. KRIŠTÍN, Anton.

Butterflies known and unknown [Motýle známe neznáme]. Lecture for Junior Science Café, Zvolen, 15.5.2018, SARVAŠOVÁ, Lenka.

Bats in the service of robotics advancement [Netopiere v službách pokroku robotiky]. Lecture for Science Café, Zvolen, 24.10.2019, NAĎO, Ladislav.

Spiders and what ecological relationships affect them [Pavúky, aké ekologické vzťahy ich ovplyvňujú]. Lecture for Science Café, Zvolen, 23.9.2021, ČERNECKÁ, Ľudmila.

Sustainable economy: vision or opportunity in turbulent times? [Udržateľná ekonomika v turbulentných časoch: Brzda či vízia rozvoja?]. Lecture for Science in the CENTRE Science Café, Slovak Centre of Scientific and Technical Information, Bratislava, 28.1.2021, KLUVÁNKOVÁ, Tatiana.

Numerous excursions along with lectures through the Mlyňany Arboretum were held annually. BOŠIAKOVÁ, Dominika – GREŠKOVÁ, Miroslava – HOLEČKOVÁ, Daniela – HOŤKA, Peter – KRAJČIOVÁ, Helena – MAJEROVÁ, Ľubomíra – PÁLKA, Ľubomír – SMRŤKOVÁ FARKAŠOVSKÁ, Viera.

### 2.7.2. Table of outreach activities according to institute annual reports

Outreach activities	2016	2017	2018	2019	2020	2021	total
Articles in press media/internet popularising results of science, in particular those achieved by the Organization	84	51	34	36	216	188	609
Appearances in telecommunication media popularising results of science, in particular those achieved by the Organization	291	46	318	358	318	314	1 645
Public popularisation lectures	80	42	56	85	5	7	275

## 2.8. Background and management. Infrastructure and human resources, incl. support and incentives for young researchers

### 2.8.1. Summary table of personnel

#### 2.8.1.1. Professional qualification structure (as of 31 December 2021)

	Degree/rank				Research position		
	DrSc./DSc	CSc./PhD.	professor	docent/ assoc. prof.	I.	II.a.	II.b.
Male	2	22	0	1	1	17	6
Female	0	18	1	0	0	7	10

I. – director of research with a degree of doctor of science/DrSc.

II.a – Senior researcher

II.b – PhD holder/Postdoc

### 2.8.1.2. Age and gender structure of researchers (as of 31 December 2021)

Age structure of researchers	< 31		31-35		36-40		41-45		46-50		51-55		56-60		61-65		> 65	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
<b>Male</b>	3.0	2.1	1.0	0.1	5.0	3.2	6.0	6.0	1.0	1.0	5.0	5.0	3.0	3.0	2.0	2.0	1.0	0.5
<b>Female</b>	0.0	0.0	2.0	2.0	5.0	4.5	4.0	4.0	1.0	1.0	1.0	1.0	2.0	2.0	2.0	2.0	0.0	0.0

A – number

B – FTE

### 2.8.2. Postdoctoral fellowships (list of positions with holder name, starting date, duration. Add brief information about each fellow's career path before and after receiving PhD degree, etc.)

#### 2.8.2.1. MoRePro and SASPRO fellowships

N/A

#### 2.8.2.2. Stefan Schwarz fellowships

Ing. Pavel Mezei, PhD.

Main focus: Bark beetle population dynamics and impact of disturbances on ecosystems, impact of natural hazards on individual trees and stands and the factors affecting the bark beetle attack on trees using statistical methods and GIS.

01/2015-12/2018

Mgr. Ladislav Nad'ó, PhD.

Main focus: Information transfer in social structures of bats - interdisciplinary approach.

01/2016-12/2019

Mgr. Mária Potterf, PhD.

Main focus: Investigation of the bark beetles population dynamics using agent-based modelling and remote sensing; identification of the effects of forest management on bark beetle outbreak.

05/2017-01/2019

Mgr. Ľudmila Černecká, PhD.

Main focus: Ecological relationships in the system host-parasitoid, determination the influence of ecological factors of the environment, such as habitat type, type of trees, altitudinal gradient on the host spectrum, and the incidence of parasitization in the communities of koinobiont parasitoids on spider hosts in the woodland landscape and ecotones.

05/2020-05/2023

#### 2.8.2.3. Postdoctoral positions from other resources (specify)

N/A

### **2.8.3. Important research infrastructure introduced during the evaluation period with the information about the sources of funding (max. 2 pages)**

During this evaluation period, we were unable to obtain any important research infrastructure due to the many calls made by the Research Agency responsible for reallocating EU Structural Funds in the R&D operational program being cancelled or not finally funded. Our institute participated in two such calls, coordinating the preparation of one project.

For the same reason, we have problems with the sustainability of our expensive research infrastructure acquired in the previous evaluation period, when we relied on the sustainability support of the following EU Structural Funds programming period.

Therefore, we operate all infrastructure only from smaller research projects from VEGA and SRDA, where in most cases, this is possible. Still, in the case of our most expensive infrastructure: UAV (Dragon 50, SwissDrones Operating AG) with a hyperspectral scanner (AisaKESTREL 10, Specim, Finland) and a laser scanner (GL-70, Geo Info, China, which use the Riegel Vux-1 lidar, Austria), thermovision system for digital thermography (DigiTherm, IGI Germany), digital camera system with the capacity of taking infrared photos (RCD 30, Leica, Switzerland) this is causing problems.

Due to various legislative restrictions, we operate the UAV in cooperation with a third party - a private company.

In addition to the mentioned EU Structural Funds projects, we participated in two proposals in Horizon 2020, Call H2020-SPACE-2018-2020. In both, we ended up on a reserve list.

For the future, we managed to ensure its operation from the successfully evaluated HORIZON-WIDERA project "Network for novel remote sensing technologies in forest disturbance ecology", which we coordinate.

### **2.9. Supplementary information and/or comments on all items 2.1 – 2.8 (max. 2 pages in total for the whole section)**

- **Participation of IFE SAS on current challenges of the program HORIZON EUROPE**

#### **Acronym: SENSAFOR**

Title: Integrated wireless SENSing framework and its future green substitute for monitoring AgroFOrEst's performance and evaluation of economic and environmental impact

Status: not approved (submitted on 6 October 2021)

Name of the person responsible for IFE SAS: Prof. Mgr. T. Kluvánková, PhD., RNDr. L. Ditmarová, PhD.

Project coordinator: FTN – Faculty of Technical Sciences, University of Novi Sad, Serbia

#### **Acronym: RESDINET**

Call: **HORIZON-WIDERA-2021-ACCESS-03**

Title: Network for novel remote sensing technologies in forest disturbance ecology

Status: approved (May 2022)

Name of the person responsible for IFE SAS: Ing. Rastislav Jakuš, DrSc.

Project coordinator: Institute of Forest Ecology SAS

#### **Acronym: COEVOLVERS**

Title: Coevolutionary approach to unlock the transformative potential of nature-based solutions for more inclusive and resilient communities

Status: approved (June 2022)

Name of the person responsible for IFE SAS: Prof. Mgr. Tatiana Kluvánková, PhD.

Project coordinator: LUKE – Natural Resource Institute, Finland

**Acronym: wildE**

Title: Climate-smart rewilding: ecological restoration for climate change mitigation, adaptation and biodiversity support in Europe

Status: approved (May 2022)

Name of the person responsible for IFE SAS: Prof. Mgr. Tatiana Kluvánková, PhD.

Project coordinator: INRAE - National Research Institute for Agriculture, Food and Environment, France

**Acronym: IMPARA\***

Title: Impacts from Social Innovation in Marginalised Rural Areas

Status: submitted (3 April 2022)

Name of the person responsible for IFE SAS: Prof. Mgr. Tatiana Kluvánková, PhD.

Project coordinator: JHI - The James Hutton Institute, UK

*\*This project follows on the SIMRA project and is presented in the schematic layout under the title Horizon-WIDERA-2022-Impact Award*

- **Activities in the urban environment**

**Phytopathological collection**

The Institute of Forest Ecology SAS manages and enhances the scientific collection of plant pathogens (Plant Pathology Herbarium) included in the international list *Index Herbariorum* under the code NR, which represents an object of significant scientific value. It is used for scientific purposes by the staff of the institute and experts from other domestic and foreign institutions. In 2021, the collection was expanded by other acquisitions obtained by own collection from the territory of Slovakia. Prior to archiving, the material was treated against pests (Department of Plant Pathology and Mycology in Nitra, curator of the herbarium collection K. Pastirčáková)

**Expertise assessment activity - determination of tree stability**

For local governments, businesses and individuals, we provide expertise services consisting of assessing the stability of woody plants by acoustic tomography using Fakopp 3D (Fakopp Bt., Republic of Hungary) and by using innovative technology we also assess the dynamic stability of the root system and resistance to tree uprooting with DynaRoot (Fakopp Bt., Republic of Hungary).

**Injection of woody plants against pests**

In the form of intra-stem injection with the BITE device using a pesticide based on soil bacterial extracts, we carry out orders for the treatment of woody plants (e.g. Horse chestnut)

**Identification of harmful organisms**

The staff of the Department of Plant Pathology and Mycology in Nitra provides advice and identification of harmful organisms in ornamental and private greenery and the proposal of protective measures for the public on request. We also determine the causes of drying and dying of trees. We determine the pathogens not only visually on the basis of the presence of characteristic symptoms, but in the absence of reproductive organs we isolate the pathogen into pure cultures. We perform identification not only on the basis of the morphological features of the pathogen, but also on the basis of DNA.

- **Significant infrastructure operation**

Since 2018, we have been operating the "Mobile Laboratory for RS" (drone with a system of scanners - laser (Lidar), hyperspectral, thermal and RGB with near-infrared) on the basis of a framework agreement with the company PHOTOMAP, Ltd., which has secured all necessary permits and operates it in accordance with applicable legislation.

- **Activities in the Slovak Academy of Agricultural Sciences**

Employees of IFE SAS (Zach P., Ditmarová L., Kulfan J.) are active members of the Slovak Academy of Agricultural Sciences (SAPV) – study field of Forestry, within which they actively participate in the creation of policies related to forestry and research of forest ecosystems in Slovakia. SAPV has been established as an important advisory body of the Ministry of Agriculture of the Slovak Republic. Dr Peter Zach was elected a member of the SAPV board in 2021.

- **Implementation of significant investment events**

In its administration, the IFE SAS has significant tangible assets, which it strives to manage efficiently and effectively. These are, in particular, the building of the institute's headquarters in Zvolen (it houses workspaces and laboratories), the operating infrastructure in the Mlyňany Arboretum and the manor house, which has significant historical value and is on the list of national cultural monuments. In the years 2016-2021, we implemented several significant investment projects aimed at the reconstruction of the mentioned infrastructure. This also significantly improved the working conditions of employees and the implementation of scientific research activities.

- **The Mlyňany arboretum**

The Institute of Forest Ecology within the Mlyňany Arboretum manages, maintains and improves:

- arboretum gene pool
- ornamental plant nurseries
- dendroexposures of the arboretum

***Meteorological observation***

In the Mlyňany Arboretum, we collect data from the automatic Meteorological Station. The obtained data is automatically sent to the organization's server. The organization's website provides a long-term history of weather in the arboretum (mean air temperature, relative air humidity, air pressure and precipitation), which is also used by scientists from other SAS organizations and universities in solving scientific projects. All data are also sent to the Slovak Hydrometeorological Institute (SHMÚ).

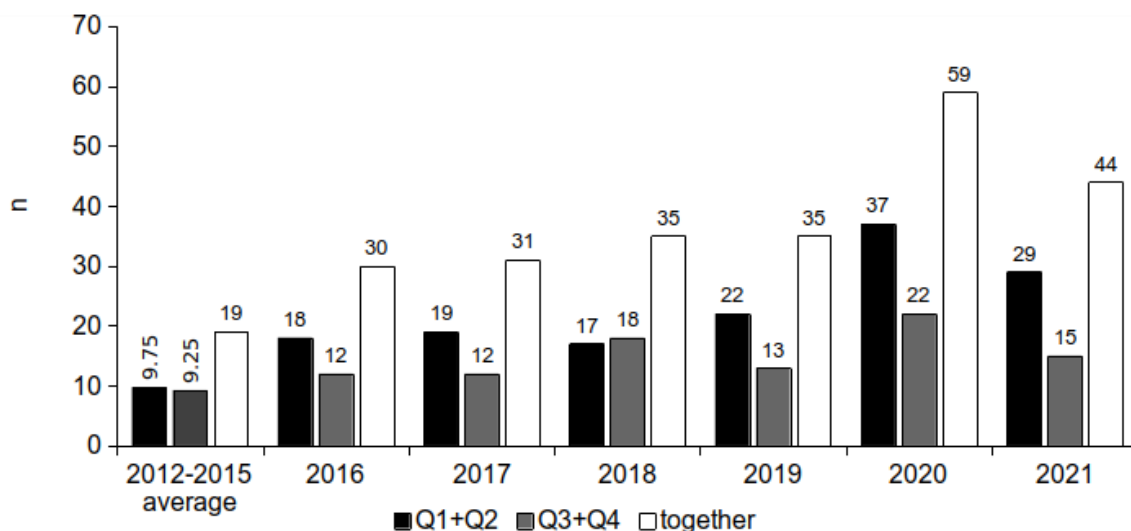
### **3. Implementation of the recommendations from the previous evaluation period**

**Recommendations of PANEL II for the Institute of Forest Ecology SAS based on regular evaluation of SAS organizations:**

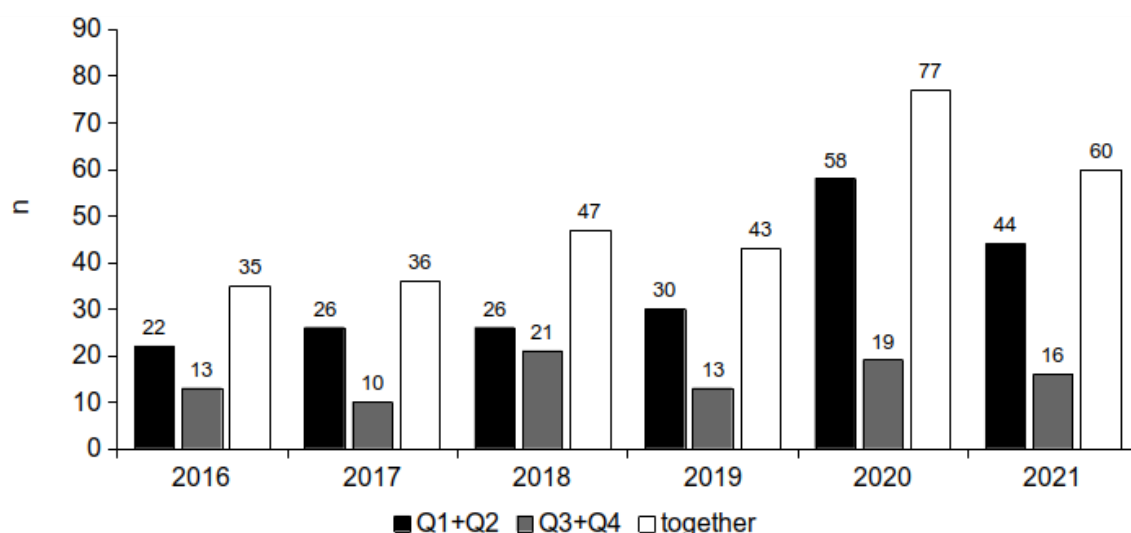
1. To increase scientific potential by improving the qualification structure - in particular by increasing the number of middle-aged DrSc researchers.
2. To increase scientific performance - quantity and quality of publications and citations.
3. Scientific intentions should be enriched by strategic planning of research activities.
4. To establish „International Advisory Board“.
5. To improve the salary conditions of young researchers in post-doc positions (in coordination with the decision-making sphere ...).
6. To monitor the quality of PhD-student's tutors and enable training only for those who are scientifically productive.
7. To improve the international mobility of our employees - especially the travel of scientists to foreign workplaces and also the recruitment of experts from abroad and their acquisition for cooperation at our workplace.

## Implementation of the recommendations:

1. IFE SAS has improved its qualification structure, in particular as regards the number of staff with IIa qualification level. In 2016-2021, 7 researchers obtained the qualification level IIa (the total number of researchers with the IIa is currently 25). In 2021 - Dr Rastislav Jakus was awarded of the scientific degree of "DrSc". In the horizon of 2 years, there is a real assumption of further 3 proposals.
2. IFE has improved its scientific performance and the quality of its scientific work. In the last years of the evaluation period, scientific production increased by more than 100% (most publications were classified in Q1 and Q2) (Fig 1 and Fig 2). IFE staff published their publications mainly in journals registered in the WOS and SCOPUS databases.



**Figure 1** IFE SAS publishing activity for the evaluation period 2016-2021 compared to the previous evaluation period (based on JCR)



**Figure 2** IFE SAS publishing activity for the evaluation period 2016-2021 compared to the previous evaluation period (based on SJR)

The institute has made considerable efforts to increase the quality of its own international journal *Folia Oecologica* (the cite score of the journal increased to 2.0 in 2021) which is indexed in the SCOPUS database, currently already in WOS database (2021).



3. Following the recommendations of PANEL II, our scientific intentions were defined within the Strategy of Scientific and Research Activities of IFE SAS for the period 2018–2023 and the Action Plan of IFE SAS.
4. In 2020, we established the International Advisory Board, which is composed of recognized international experts in the field of ecology and forest ecology from Austria, Germany, the Czech Republic and Sweden. In October 2021, a meeting of the International Advisory Board (IAB) of IFE SAS was held. The Advisory Committee prepared an Evaluation Report based on a study of the available materials and an extensive discussion with the institute's management and research team leaders. As part of its report, the IAB stated that significant progress had been made in the quality and productivity of the institute's scientific work, in the organizational area also in terms of the social impact of the institute's activities compared to the results of the last accreditation in 2016. The Advisory Committee recommended IFE SAS to increase the horizontal cooperation of the departments, resp. research teams e.g. by linking their cooperation in a newly-designed project. Regarding the organizational structure of the institute, the IAB proposed to group some departments into larger units on a single thematic platform - in line with the Institute's Strategy.
5. We strive to improve the salary conditions of young researchers as well as senior researchers, especially on the basis of quality and productivity of scientific work. Employees with the best performance evaluation are regularly rewarded, and since 1 January 2020, employees who achieved exceptional scientific performances in the previous year have been rewarded differently (these performances are reassessed annually). Currently, we have also started to apply the motivational evaluation of research teams within the management associated with the bonus of the best.
6. We regularly monitor and evaluate the [quality of supervisors and PhD students](#). We have set our internal criteria in accordance with the currently valid system of evaluating the quality of PhD studies at the SAS. We make it possible to list the topic of the dissertation only to those supervisors who meet the set criteria.
7. The international mobility of our researchers and PhD students during 2016-2021 has increased significantly compared to the previous period. Detailed information on the mobility of IFE SAS staff and doctoral students is provided annually in the IFE SAS Annual Reports (Appendix E), which are published on the websites [www.sav.sk](http://www.sav.sk), [www.ife.sk](http://www.ife.sk). In the mentioned period, several long-term internships of our doctoral students and researchers abroad, resp. admissions of experts from abroad to IFE SAS were carried out.

We give as an example:

2016

- Julius Barner, Germany – 48-day working stay at IFE SAS
- Herbert Hoi, Austria – 22-day working stay at IFE SAS

2017

- Lenka Sarvašová, PhD student IFE SAS – 90 days – Spain - ERASMUS programme

2018

- Branislav Hroščo – PhD student IFE SAS – 104 days, Czech Republic - ERASMUS programme
- Eva Ľuptáková – PhD student IFE SAS – 90 days, Czech Republic - ERASMUS programme
- Marek Dzurenko – PhD student IFE SAS – 90 days, USA – SAIA (National Scholarship Programme)

2019

- Musa Kirisik, Turkey – 40-day working stay at IFE SAS

The international mobility of our researchers and doctoral students in the period 2020-2021 was significantly affected by the pandemic situation. Most foreign business trips and internships have been canceled or postponed. Despite the difficult situation, 1 doctoral student (H. Húdoková) participated in a 3-month research internship in Serbia (The University of Novi Sad), 1 independent researcher (P. Mezei) had received a significant Fulbright scholarship, on the basis of which he participated in long-term work stay in the USA (6 months) since August 2021 and 1 senior researcher (P. Zach) had been to a 3-month research stay in the Czech Republic since November 2021.

Since December 2016, Ing. Rastislav Jakus, DrSc. has been one of the international research members in the project "Building up an excellent scientific team and its spatio-technical background focused on mitigation of the impact of climatic changes to forests from the level of a gene to the level of a landscape (EXTEMIT-K)" at Czech University of Life Sciences in Prague.

#### **4. Research strategy and future development of the institute for the next five years**

**Research strategy of the institute in the national and international contexts, objectives, and methods (including the information on when the strategy was adopted)**

The institute is currently focused on a comprehensive basic and theoretical-methodological research of ecology and biology of domestic and introduced woody plants and other organisms, functionally related to woody plants and forest ecosystems. It is mainly about learning about long-term changes, processes and stressors important for the stability, production and protection of ecosystems and their components (Foundation Charter of IFE SAS).

The Institute's research strategy for the next period (2024-2028) will focus on research into the impact of global change on terrestrial ecosystems (especially forest), analysis of the causes, impacts and adaptations of ecosystems, including the socio-economic aspects of global change.

The IFE SAS strategy until 2028 defines the vision, values and mission of the institute and proposes strategic tasks to achieve the desired state. Subsequently, the Action Plan will also be updated with specific objectives and deadlines in all relevant areas.

**Basic starting points** of the research strategy and future development of the institute for the following period:

- Strategy of the Institute of Forest Ecology SAS for the period 2018-2023
- Recommendations and comments of the International Advisory Board IFE SAS
- Strategy of the SAS 2030
- The concept of nature and landscape protection until 2030 (Ministry of the Environment of the Slovak Republic and the State Nature Protection of the Slovak Republic; November 2019) and international obligations arising from the Convention on Biological Diversity
- Research and innovation strategy for intelligent specialization of the Slovak Republic - RIS3
- European forestry research strategy for the sustainability and multifunctionality of forests in the context of global change
- Key societal and scientific challenges to which the institution will respond

#### **IFE SAS vision**

- Building a modern and respected European scientific institution, the results of which have a significant social impact
- As part of its mission, IFE SAS will carry out high-quality basic research, educate young scientists, develop international cooperation as much as possible and communicate its scientific knowledge with the public. In the conditions of the new organizational form (IFE SAS became a public research institution on January 1, 2022) to work on intensifying cooperation with the public and business sector regarding the transfer of knowledge into practice

**The actual fulfilment** of the vision is based on the basic principles of the institute's activities:

- Realization of research comparable with important workplaces of similar focus in the international context
- Support for collaboration across specialized research teams to address integrating projects
- Support for international cooperation (within major international projects and mobilities)
- Human resources care and development (support for further education and career growth)
- Effective and transparent management of the institution based on strategic planning
- Building an institution that is attractive to employees and the public

## Research priorities

Global changes, accompanied in particular by increasing CO<sub>2</sub> concentrations in the atmosphere, rising temperatures and changes in precipitation regimes, are significantly affecting the growing season, growth, health and the expansion of forest ecosystems. This results in, for example, an increased risk of floods, soil erosion or forest fires. Forests cover more than 40% of Slovakia's territory and, as they are very sensitive to the effects of climate change, they are becoming critically endangered ecosystems. At the same time, temperate forests represent more than 40% of the capacity for carbon absorption by plant physiological processes and are therefore the most important asset of an ecosystem service called climate regulation with strategic potential for transformation to a low-carbon society.

Based on the currently available scientific capacities and infrastructure at IFE SAS, we have set 2 key **strategic research priorities** for the following period 2024-2028:

1. Research on ecological interactions in forest and urban ecosystems in the context of climate change
2. Research on the adaptation of ecosystems to global change

<b>1. Research on ecological interactions in forest and urban ecosystems in the context of climate change</b>
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Within the mentioned research priority, we will focus mainly on the following areas:

### ***Analysis of the biodiversity, invasive species and evolutionary biology***

In the given research area greater attention will be paid to forest protection against native and non-native insect species, and habitat conservation using abundant or scarce species of invertebrates and vertebrates as indicators of environmental change. Research activities at the national level will be linked to those of the Forest Research Institute/Forest Protection Service and the State Nature Conservation in Slovakia. Research at the international level will reflect the scope of the European Forest Ecosystem Research Network (EFERN) as an essential basis to enable better integration and co-operation in the research of forest ecosystems and ecology of tree species within Europe. Linking the research strategy to climate/environmental change has been adopted recently as a consequence of gathering long-term scientific data on phenology and dynamics of forest insects, specifically moths and beetles, in prevalent forest ecosystems in Slovakia.

In the next period, the research strategy of the Evolutionary and Behavioural Ecology Research Group will focus on four topics mainly: 1) application of bio-inspired algorithm, 2) trait-based ecology, 3) climate-driven evolution of endemism and 4) ecological genomics. These topics are developed on our current research which started five or even fifteen years ago and are highly potent extensions towards edge-cutting ecological research. All four strategic topics are original in terms of the discipline and the first of them includes an interdisciplinary approach. Namely, we will study various aspects which shape collective intelligence algorithm in swarming behaviour of bats; spatial components of taxonomic, functional and phylogenetic diversity of orthopteroid insects in relation to ecological and evolutionary drivers; phylogeography, habitat preference and spatial activity of the endangered endemic bush-cricket; and we will do genome-wide insights into evolutionary potential and survival of fragmented animal populations. Besides these topics we will continue in parallel on the ongoing study of the influence of altitude and habitat on the parasitization of arboreal spiders and population genetics and GPS telemetry of the least known bat species in Europe, the giant noctule. To achieve our goals, we will employ our well-built infrastructure (molecular lab, tracking equipment, experimental rearing facility) and cooperation with computer scientist and other colleagues from the field.

### ***Analysis of the tree health in forest and urban environment***

Our future focus of tree health state evaluation research is aimed to determine influence of various species of wood decaying fungi on tree vitality and stability in forest and urban environment. We will adopt additional methods of whole tree stability evaluation focusing on root system and comparison of various non-destructive methods.

Considering the climate change, it is expected that pines will replace species like spruce, beech, and fir, for which growth conditions will become more or less unsuitable. Therefore, the knowledge of the health state of pines and the diversity, biology, possible pathways and pathogenicity of currently identified microscopic fungi of these host trees is a current issue in phytopathological research and is important on both national and international scale. The objective of our research for the next years will be to study the temperature adaptation and to model the potential geographical distribution of selected fungal pathogens of pines as their response to climatic change. Because disease outbreaks are caused by interactions among pathogen, host, and environment, we will concentrate on the pathogenicity of parasitic fungi as well as different levels of disease susceptibility and resistance in host trees. In the light of climate change, a dieback of Scots pine associated with ophiostomatoid fungi can be observed in several regions affected by long-term drought and an increased average annual temperature. Ophiostomatoid fungi are closely associated with bark beetles. The fungi colonize cambial tissue, develop fruiting bodies in the bark beetle galleries, and release dark-coloured pigments that degrade timber's technical quality. Our further objectives for the next years will include the research of interactions between the ophiostomatoid fungi, Scolytid bark beetles and Scots pine, including determination of pathogenicity of isolates of dominant fungal species and their possible impact on the pine forests dieback in Slovakia.

### ***The dynamics of forest ecosystems processes in relation to environmental changes***

The research strategy in this area is designed to achieve the following goals:

- examine the ability of the forest ecosystem to self-revitalize after removal or reduction of emissions from the emission source
- clarify the impact of changing environmental conditions on the growth and production processes of the wood component of forest ecosystems
- identify changes in the mycoflora and determination of phytopathological manifestations of forest trees in the temperate zone influenced by ongoing anthropogenic activity
- evaluate the phenological response of selected forest trees and herbs in relation to global environmental change over the last twenty-five years
- develop a model of spatio-temporal dynamics of nutrient content, risk elements (e.g. heavy metals content, ozone concentration, sulfur deposition) and energy in soil and plant biomass - find out the current values of translocation (transfer coefficients) of selected risk and toxic elements in the soil-plant system and the risk of potential contamination of food chains
- derive model values of combustion heat of basic components (wood, bark, needles) of above-ground dendromass of selected forest trees.

At the national level, this research will be carried out in the framework of 3 currently ongoing national projects. The international research reach will be saturated with the iSBio and ERDF projects. Within the framework of the inter-academic agreement between IFE and Czech Agricultural University in Prague (2016-2026), cooperation is realized through the sharing of instrumentation and laboratory technology at both workplaces, publication of joint scientific results and regular organization of an international scientific conference focused on plant ecology and physiology "Influence of abiotic and biotic stressors on plant properties". Methodologically, our research activity is based on a comparison of the processes running in anthropogenically disturbed forest ecosystems against a less disturbed environments. Finally, our efforts will be focused on the creation of a model of processes running in the forest ecosystems, representing the synthesis of previous knowledge with the follow-up to the new strategy in the context of the research priorities of the institute.

## 2. Research on the adaptation of ecosystems to global change

Within the mentioned research priority, we will focus mainly on the following areas:

### ***Forest ecosystems and disturbance regimes in climate change conditions***

In the next period, the research strategy of the Disturbance Ecology Research Group will focus on two topics: 1) bark beetle spreading mechanism and resistance to bark beetle attacks assessment on a tree and habitat level, and 2) spruce–bark beetle interactions and the role of semiochemicals. Global change plays an important role in both topics, which can increase the number of generations of bark beetles on one hand and increase the stress and predisposition of spruce on the other one. These topics are developed on our current research at the national level in SRDA project “Norway spruce response to acute stress in relation to bark beetle attack” and VEGA project “Resistance of Norway spruce (*Picea abies*) to the bark beetle attack in changing climate conditions”, within which we cooperate with Czech University of Life Sciences in Prague. At the international level, we will coordinate the successfully evaluated HORIZON-WIDERA project RESDINET - “Network for novel remote sensing technologies in forest disturbance ecology”, on which we will cooperate with top partners in the field - the Finnish Geospatial Research Institute and the Swedish University of Agricultural Sciences.

We will employ our well-built infrastructure (UAV with hyperspectral, thermal and Lidar sensors, field infrastructure collecting the data from trees, soil and weather, GC-MS and analytical chemistry lab).

### ***Climate extremes, stress factors and adaptive potential of forest trees***

As the key strategic research priorities in the research area for the following period are:

- new perspectives on the adaptation of forest ecosystems to global environmental change and the acceleration of tree phenotyping: identification of useful forest populations for future forestry practices using the physiological, morphological and biochemical markers,
- development of methodology for identification and quantification of production and survival risks of individual tree species and their provenances based mainly on dendrometric time series in connection with abiotic stressors - linking time series with isotope analyses in tree rings,
- research of adaptive potential of forest tree species using an integrated approach with a combination genetic, biochemical and ecophysiological research.

This approach has also been realized by cooperation with another scientific laboratories and research teams within national (currently 5 ongoing projects; 1 forthcoming SRDA project - “*Adaptive variation of genetic resources of forest trees under climate change*”), and international projects (submitted Horizon Europe 2022 - 2026 project *SENSAFOR*; submitted bilateral mobility project with CzechGlobe, CAS; 1 forthcoming COST Action CA 21138 - *CLEANFOREST* project 1 approved Visegrad fund project in May 2022 - “*Network establishment for V4 wetland forest protection - NERVE4 Action*”).

In our research methodology, a new concept of three-dimensional approach to enhance adaptation and resilience to climate change within forest ecosystems, optimising the provision of ecosystem services will be adopted. This was developed under *CLIMO* - the one of two recently completed (2021) Cost Action projects.



## ***Human dimension of global environmental changes and ecosystem services***

SlovakGlobe - joint workplace of IFE SAS and the Slovak University of Technology, plans are to explore research themes to contribute to:

- Conceptualisation of the theory of commons for carbon-neutral transformation in particular knowledge co-production on novel governance for climate smart and digital transformation under two forthcoming Horizon Europe (2022 - 2026) projects: wildE and COEVOLVERS – in Grant Agreement preparation.
- Completing editing of special issue: The role of social innovation in steering the sustainable governance of nature in Journal of [\*Environmental Policy and Governance\*](#) (3 contributions for SEA team in forthcoming).
- Exploring behavioural research and transdisciplinary model of knowledge co-production developed under the recently completed H2020 project SIMRA to study variables of societal transformation to climate-neutral societies (project COEVOLVERS, COST *action* MARGISTAR and national grant agency project VEGA).

*Intergenerational collaboration and education:* expanding existing PhD committee on Sectoral Economics and Management under the SlovakGlobe partnership with the Slovak University of Technology - planned in medium term (up to 4 years). Completing a textbook on the management of global change (2023).

## **Transfer of knowledge into practice**

We see significant potential for the transfer of knowledge into practice based on previous experience, infrastructure and implemented contracts in the following areas:

1. Tree health stability assessment
2. We plan to further use our developed decision support system for disturbances in spruce ecosystems - TANABBO. This system makes it possible to 1) operatively indicate the sites with the highest risk of infestation by bark beetles during the year based on a model of predisposition to attack and a phenological model of bark beetle population development and 2) predict the size and location of disturbance in the following year based on time series of remote sensing data.
3. Expertise, assessments and professional consultations for state organizations (e.g. State Nature Protection, Ministry of the Environment of the Slovak Republic) and the private sector
4. Mlyňany Arboretum - educational activities for children, youth and the general public (a special educational program in the environment of the arboretum, which uses activating methods and forms of experiential learning and project teaching). Sale of ornamental plants (from own propagated and grown material)