http://www.uf.a.u-tokyo.ac.jp/hokuen/Abies2016/

Abies 2016

The 15th International Conference on Ecology and Silviculture of Fir
Bringing Knowledge on Fir Species Together

Period: 21-24 September 2016

Venue: School of Agriculture, Hokkaido University
Kita-9, Nishi-9, Kita-ku, Sapporo, JAPAN

Co-Chair: Andrej Bončina
Masato Shibuya

Contents

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School of Agriculture／Graduate School of Agriculture／Research Faculty of Agriculture

IUFRO-Japan

Organization

Organizers

IUFRO WP 1.01.09 Ecology and silviculture of fir

The Boreal Forest Society, Japan

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Preface

It is a great pleasure for us that the IUFRO conference "*Abies* 2016: The 15th International Conference on Ecology and Silviculture of Fir" will be held in Hokkaido University, Sapporo, Japan, in September 2016. Fifty-eight participants from Europe, North America and Asia will be joined in the conference. This is the first *Abies* conference which will be held in Asian region. In September, the weather in Sapporo is mild, and the coloring of the leaves starts in the high altitudes. Hokkaido University is one of the oldest university in Japan and was founded in 1876. We are looking forward to meeting you in Sapporo. We hope that you will enjoy the conference and stay in Sapporo and Hokkaido and that the conference will be fruitful to you.

Dr. Andrej Bončina
Coordinator of 1.01.09 Ecology and Silviculture of Fir
Professor of forest management and planning, University of Ljubljana, Slovenia

Dr. Masato Shibuya
Chief of Local Organizing Committee,
Associate Professor, Research Faculty of Agriculture,
Hokkaido University, Japan

Scientific Committee

Dr. Andrej Bončina (Chair, Coordinator IUFRO WP 1.01.09), Slovenia
Dr. Dorota Dobrowolska (Deputy Coordinator IUFRO WP 1.01.09), Poland
Dr. Raphael Thomas Klumpp (Deputy Coordinator IUFRO WP 1.01.09), Austria
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Dr. Gary Kerr, United Kingdom
Dr. Masato Shibuya, Japan
Dr. Takeshi Seki, Japan

Local Organizing Committee

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Dr. Toshizumi Miyamoto (Hokkaido University)
Dr. Hideyuki Saito (Hokkaido University)
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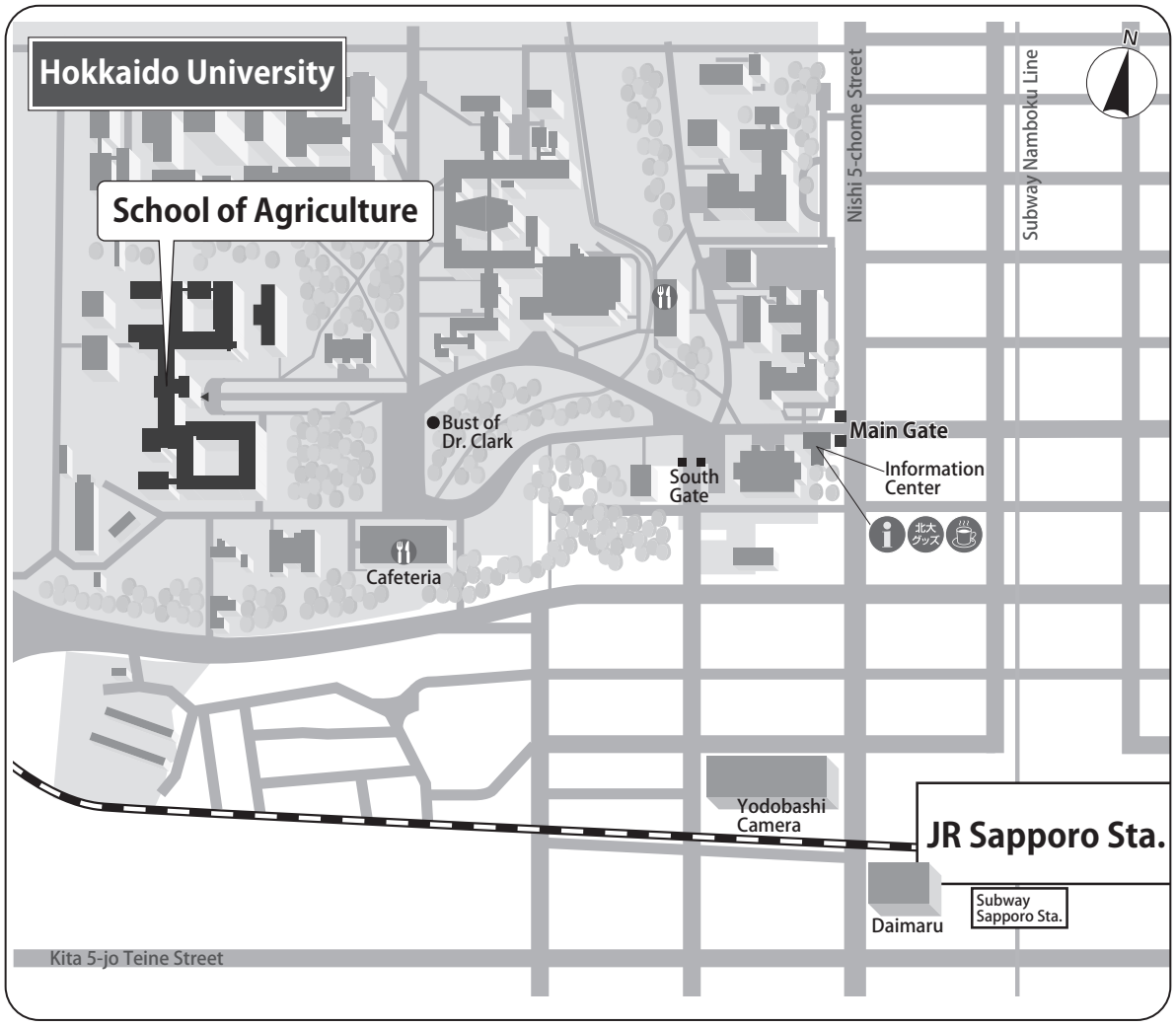
Dr. Wataru Ishizuka (Forestry Research Institute, Hokkaido Research Organization)
Mr. Keisuke Yano (Forest Tree Breeding Center, Forestry and Forest Products Research Institute)

Conference Staff

Mr. Yukihiro Koike (The University of Tokyo Hokkaido Forest)
Mr. Nozomi Oikawa (The University of Tokyo Hokkaido Forest)

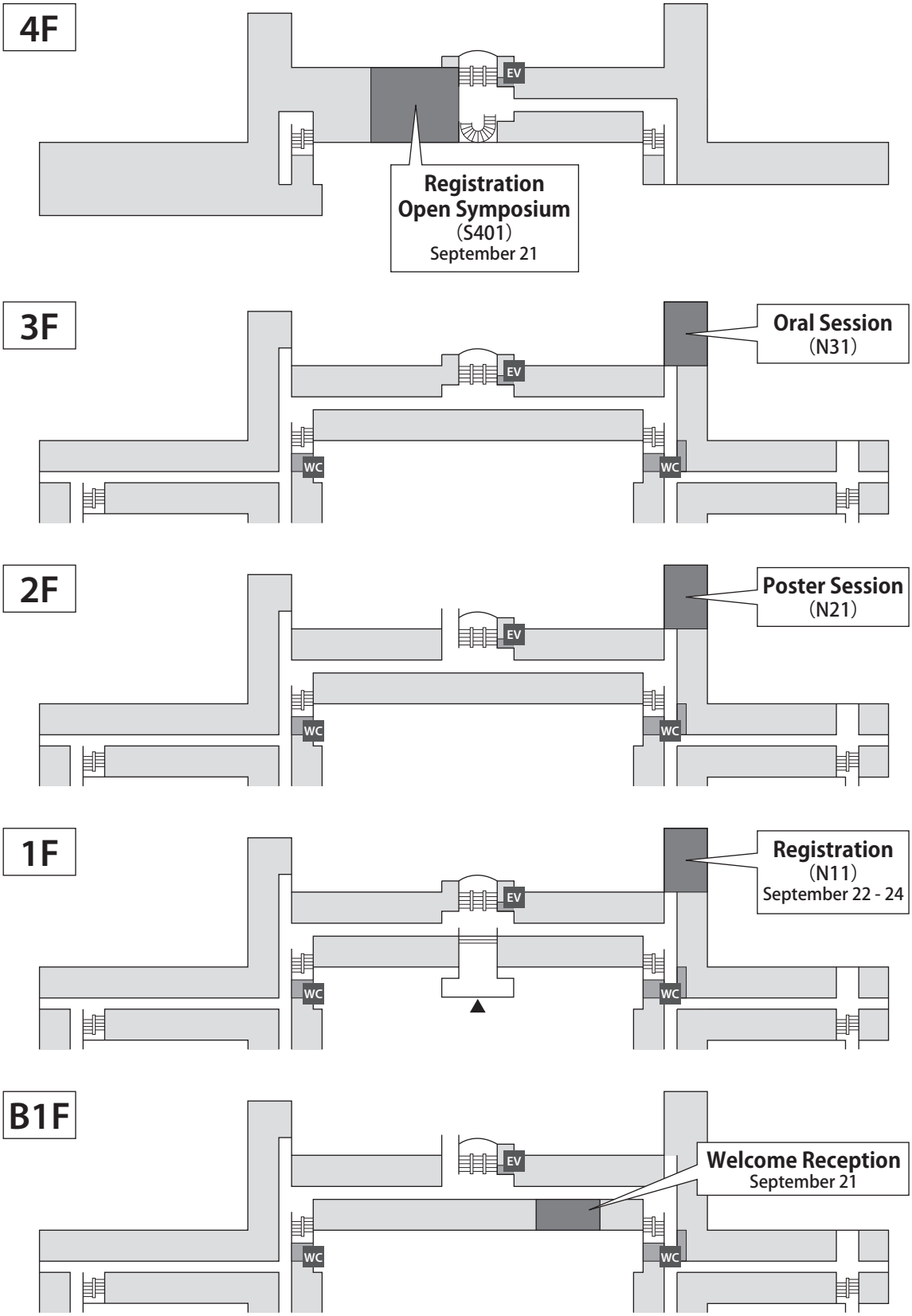
Access Map



■New Chitose Airport – Sapporo by Rapid Airport Express. 15-min. intervals（※）36 min. (fastest)

※The departure frequency varies by time of day. Inquire at JR New Chitose Airport Sta. or JR Sapporo Sta.

Floor Map


4F
EV
Registration
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(S401)
September 21
3F
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WC
WC
Oral Session
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2F
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WC
WC
Poster Session
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B1F
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WC
WC
Welcome Reception
September 21

Information for Participants, Chairs and Presenters

General Information for Participants

1. Reception

Conference kit, on-site registration, and other general inquiries are available during the following hours at the venue.

Date	Open Hours	Room No.
September 21, Wednesday	13:00-17:30	S401 (4F)
September 22, Thursday	8:30-16:00	N11 (1F)
September 23, Friday	9:00-12:30	N11 (1F)
September 24, Saturday	9:00-15:30	N11 (1F)

<On-site Registration fee>

Full Registration: 50,000 JPY for regular participant and 40,000 JPY for student

Banquet Ticket for Student or Accompanied Person: 5,000 JPY

Only payment in Japanese yen in cash or credit card are acceptable.

<Wi-Fi key-code>

Wi-Fi (wireless LAN) is available in lecture room. The key-code is distributed on the reception.

2. Welcome Reception

Welcome Reception will be held at Cafeteria at the first floor of a basement (B1) of the venue from 17:30 on September 21, 2016.

3. Banquet

Banquet will be held at Sapporo Beer Garden after In-Conference Tour on September 23, 2016. Dress code is casual, and the clothes for trekking is welcome due to the schedule just after In-Conference Tour. The transportation of In-Conference Tour and banquet is by bus. If you skip to take part in the In-Conference Tour, you need to go to the venue of banquet yourself. It takes about 10-min. by Taxi from North-Exit of JR Sapporo Railway Station to Sapporo Beer Garden (Taxi fee is about 1,000 JPY).

Instruction for Chairs

1. **Arrival**
   Chairpersons are requested to be seated at the chairs' sheet located in the front of lecture room no later than 5 minutes before the session (Room No.: N31).

2. **Session Progress**
   Chairpersons are asked to ensure that all presentations start and finish punctually as scheduled.
   Staffs will assist with the remaining time of presentation and discussion.

Instruction for Oral Presenters

1. **Time Allocation**
   Symposium Lectures: Presentation 35 min. + Discussion 5 min. (Total: 40 min.)
   Keynote Lectures: Presentation 45 min. + Discussion 5 min. (Total: 50 min.)
   Oral Presentations: Presentation 17 min. + Discussion 3 min. (Total: 20 min.)

2. **Presentation Materials**
   Presentations must be in English.
   All the oral speakers should come up to **"Speaker Ready Desk (on the 1st floor)" on the day before their presentations** to upload and check their ppt files. Only Powerpoint for presentation on a LCD video projector is accepted. Oral presentation room will be equipped with the following items:
   A PC running Windows 7 operating system, with MS Office (Powerpoint 2013 version), an LCD projector, microphone, a pointer
   The presenter should bring his/her presentation file in a format compatible with the above applications and stored in the USB drive (flash disk) or a CD-ROM.
   For movies, films and animations, the presenters must confirm that they work properly, sufficiently before presentation.
   Please keep the allocated presentation time.

3. **Timing**

In order to maintain the schedule, you are requested to keep time allocation strictly. Staffs will assist with the remaining time of presentation and discussion.

Instruction for Poster Presenters

1. **Set-up/Removal**

Set-up	Removal
September 22, Thursday 8:30-10:30	September 24, Saturday 15:00-15:30

* Posters will be presented throughout the conference period on panels in the Poster Exhibition Room. Any posters remaining on panels after the removal time will be discarded by the secretariat.

2. **Poster Presentations**

Group A (odd numbers): September 22, Thursday 13:00-14:00
Group B (even numbers): September 22, Thursday 14:00-15:00
During the allocated time, presenting authors must be available at their posters for questions and discussion.

3. **Dimension**

The poster size should be A0 size (1,189 mm high × 841 mm wide).

Information for In-Conference Tour Participants

1. **Departure**

   On September 23, Friday, after a short guidance of In-Conference Tour while eating lunch in the lecture room, we will depart by bus from the conference venue, School of Agriculture, Hokkaido University. The lunch box is prepared at the lecture room. The departure time is about 12:30am.

2. **Location**

   We will visit Forest Tree Breeding Center and Nopporo Forest Park, located at 15 km east from conference venue, Hokkaido University. In Forest Tree Breeding Center, the breeding studies for *Abies* and other boreal trees are lectured. In Nopporo Forest Park, both the natural forests and man-made *Abies* forests are lectured.

3. **Return**

   After the In-Conference Tour, we will move directly to banquet at Sapporo Beer Garden. Participant who will not attend to banquet can return back to JR Sapporo Railway Station at around 6:30-7:00pm.

4. **Clothes**

   Participants should have good shoes and a jacket for trekking. Be sure to bring rain gear.

   After the In-Conference Tour (before the banquet), you don't have to change your clothes to formal ware because the clothes for the trekking is welcome at Sapporo Beer Garden.

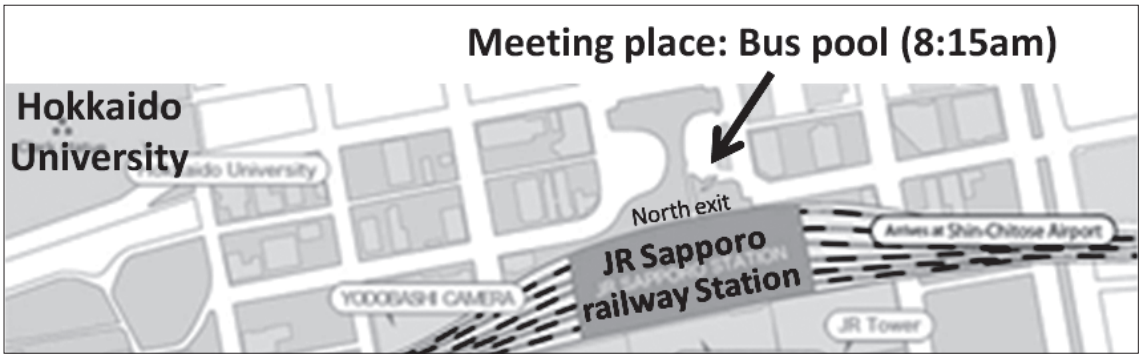
5. **Others**

   Details are described in Website of *Abies 2016*.
   (http://www.uf.a.u-tokyo.ac.jp/hokuen/Abies2016/)

Information for Post-Conference Tour Participants

1. **Departure**

   We depart by bus from JR Sapporo Railway Station at 8:30am on September 25, Sunday. All participants must gather until 8:15am. The meeting place is at Bus Pool of JR Sapporo Railway Station, located at the right side of North-Exit of the railway station (see MAP below).



2. **Return**

   Return to Sapporo Railway Station at around 5:00pm on September 28, Wednesday.

3. **Clothes**

   Participants should have good shoes and a warm jacket for trekking. Be sure to bring rain gear.

4. **Emergency contact**

   Owari T. E-mail: owari@uf.a.u-tokyo.ac.jp
   Saito H. E-mail: saitoo@for.agr.hokudai.ac.jp

5. **Others**

   Details are described in the Website of *Abies 2016*.
   (http://www.uf.a.u-tokyo.ac.jp/hokuen/Abies2016/)

Program

Program

Open Symposium: 3 invited lectures (40 min.)
Conference: 5 sessions with 3 keynotes (50 min.), 23 papers (20 min.), and 32 posters

Wednesday 21 September 2016

13:00-14:00 **Registration**

14:00-14:20 **Welcome addresses for Open Symposium**

14:20-15:00 **OS-1** **Stand dynamics of silver fir-European beech forests**
by Andrej Bončina (Slovenia)

15:00-15:40 **OS-2** **Structure and regeneration of silver fir in natural mixed stands: Implication for silviculture**
by Dorota Dobrowolska (Poland)

15:40-16:20 **OS-3** **On the gene ecology in European fir species**
by Raphael Thomas Klumpp (Austria)

16:20-16:30 **Refreshment break**

16:30-17:00 **General discussion**

17:00-17:30 **Registration**

17:30-19:30 **Welcome reception (B1 : Cafeteria)**

Thursday 22 September 2016

08:30-09:00 **Registration**

09:00-09:10 **Opening addresses**

09:10-10:00 **Keynote 1** ***Abies*: an overview of the firs of the world**
by Aljos Farjon (United Kingdom)

10:00-10:30 **Refreshment break**

Session 1 Biogeography and phylogenetics of fir species
(Chair: Takeshi Seki)

10:30-10:50 **S1-1** **Spatio-temporal distribution and ecology of *Abies* in the Korean Peninsula**
by Woo-seok Kong (Korea)

10:50-11:10 **S1-2** **Spatial patterns of fading *Abies alba* in Western Carpathians, Europe**
by David Janík (Czech Republic)

11:10-11:30 **S1-3** **Phylogeography and evolution of the Mediterranean firs**
by Anass Terrab (Spain)

11:30-11:50 **S1-4** **Phylogenetic relationships and taxonomic diversity of genus *Abies* inferred from nuclear and cytoplasmic DNA**
by Svetlana Semerikova (Russian Federation)

11:50-12:00 **Group photo**

12:00-13:00 **Lunch break**

Poster Session

13:00-14:00 **Poster presentations (Group A)**

14:00-15:00 **Poster presentations (Group B)**

15:00-15:20 **Refreshment break**

Session 2 Demography and mycology of fir forests

(Chair: Raphael Th. Klumpp)

15:20-15:40 **S2-1** **Opportunist, generalist or specialist: Fir regeneration strategies and microsite preferences in the Carpathian mixed beech forests**
by Olga Orman (Japan)

15:40-16:00 **S2-2** **An individual tree growth model for Todo fir (*Abies sachalinensis* (Fr. Schmidt) Masters) in Hokkaido, northern Japan**
by Mika Takiya (Japan)

16:00-16:20 **S2-3** **Mortality functions for *Abies balsamea* and *Abies lasiocarpa* for Western North America in relation to tree size, stand competition and climate**
by Francesco Cortini (Canada)

16:20-16:40 **S2-4** **Incidence and factors influencing root and butt rot in Todo fir stands in Hokkaido, Japan**
by Sawako Tokuda (Japan)

Friday 23 September 2016

09:00-09:50 **Keynote 2** **Species interactions, neighbourhood dynamics and complexity science: management options for North American *Abies* forests**
by K. David Coates (Canada)

09:50-10:20 **Refreshment break**

Session 3 Effects of ungulate browsing on fir forests
(Chair: Dorota Dobrowolska)

10:20-10:40 **S3-1** **Balsam fir growth and forest regeneration under increased browsing pressure from moose**
by Antoine Boudreau LeBlanc (Canada)

10:40-11:00 **S3-2** **Influence of large ungulates on silver fir-European beech forest vegetation: comparison between fenced and unfenced sites**
by Tina Simončič (Slovenia)

11:00-11:20 **S3-3** **Relative contributions of plant competition and browsing by white-tailed deer on the performance of planted balsam fir**
by Maxime Brousseau (Canada)

11:20-11:40 **S3-4** **Does browsing resilience of saplings differ among provenances? A genecological study with simulated browsing**
by Andrea Doris Kupferschmid (Switzerland)

11:40-12:30 **Lunch**

12:30-18:30 **In-conference tour**

18:30- **Banquet**

Saturday 24 September 2016

09:00-09:50 **Keynote 3** ***Abies* species in Japan, and natural stands and plantations of *A. sachalinensis* in Hokkaido**
by Masato Shibuya

09:50-10:20 **Refreshment break**

Session 4 Climate change and natural disturbances in fir forests
(Chair: K. David Coates)

10:20-10:40 **S4-1** **Disturbance history of old-growth mixed beech-fir-spruce forests in Western Carpathians**
by Michał Adamus (Poland)

10:40-11:00 **S4-2** **Increased mortality of *Abies sachalinensis* following a wind-disturbance in a natural mixed forest**
by Toshiya Yoshida (Japan)

11:00-11:20 **S4-3** **Is *Abies alba* more susceptible to ice damage as other tree species in mixed forests of Central Europe?"**
by Matija Klopčič (Slovenia)

11:20-11:40 **S4-4** **Differentiated impact of climate and soil on primary and secondary growth of *Abies alba* Mill.**
by Paulina E. Pinto (France)

11:40-12:00 **S4-5** **Disentangling the effect of climatic and genetic factors contributing to *Abies alba* Mill. tree-ring growth variation along the Italian peninsula**
by Carlo Urbinati (Italy)

12:00-13:00 **Lunch**

Session 5 Fir forest management (Chair: Toshiaki Owari)

13:00-13:20 **S5-1** **Characterizing *Abies sachalinensis* among plantation species in Japan**
by Ryogo Nakada (Japan)

13:20-13:40 **S5-2** **An analysis to maximize Todo fir profitability through optimal silviculture system selection under economic and site condition uncertainties**
by Tohru Nakajima (Japan)

13:40-14:00 **S5-3** **Short-term effects of cleaning-respacings in a silver fir-dominated stand**
by Valeriu-Norocel Nicolescu (Romania)

14:00-14:20 **S5-4** **Maintaining biodiversity in subalpine fir (*Abies lasiocarpa*) forests managed for wood production**
by Sybille Haeussler (Canada)

14:20-14:40 **S5-5** **Monks and forests in the northern Italian Apennines: legacies of historical land-use on present forest structure and processes**
by Renzo Motta (Italy)

14:40-15:00 **S5-6** **Management based on traditional local knowledge and conservation of *Abies alba* in Calabria (Southern Italy)**
by Francesco Iovino (Italy)

15:00-15:30 **Refreshment break**

15:30-16:00 **IUFRO WP 1.01.09 business meeting**

16:00-16:20 **Closing addresses**

Sunday 25 September 2016

08:30 **Departure for *post-conference tour* from Sapporo Railway Station**

Poster presentation

P-01 **Phylogenomics and species delimitation in the Mediterranean firs**
by Francisco Balao

P-02 **A complex evolutionary history shaped the distribution of *Abies alba* (Mill.) genetic variation along the Apennines**
by Carlo Urbinati

P-03 **Range shift and introgression of three Japanese *Abies* species: insights from microsatellite, mtDNA and species distribution modelling**
by Kentaro Uchiyama

P-04 **Nuclear genome size of *Abies sachalinensis* in Hokkaido Island, Japan**
by Hideyuki Saito

P-05 **Molecular selection for low water availability and extreme temperatures in the Mediterranean *Abies* species: a SNP approach**
by Juan Luis Garcia-Castaño

P-06 **Genetic structure of the relict Spanish fir *Abies pinsapo* Boiss.: an ABC approach**
by José Manuel Sánchez Robles

P-07 **Evaluation of genetic structure and diversity within and among populations of an endemic species, *Abies veitchii* var. *shikokiana* in Shikoku, Japan**
by Masakazu G. Iwaizumi

P-08 **Diameter structures in mixed species, near-natural and natural stands with *Abies alba***
by Rafał Podlaski

P-09 **Changes in the population structure of *Abies firma* in a temperate mixed forest located in Fukushima Prefecture, eastern Honshu, Japan**
by Megumi K. Kimura

P-10 **Regeneration niche of *Abies firma* in the species-rich temperate mixed forest: a multi-scale analysis linking geographical distribution, stands and reciprocal patches**
by Yoshihiko Hirabuki

P-11 **Recruitment, growth and mortality of Sakhalin fir (*Abies sachalinensis*) in northern Japanese mixedwood stands managed under selection system**
by Toshiaki Owari

P-12 **The influence of gap size on growth and development of silver fir regeneration in near-natural mixed stands in the Świętokrzyskie Mountains**
by Piotr Wrzesiński

P-13 **Fir and its ectomycorrhiza from local to global scale**
by Tina Unuk

P-14 **Decaying and development of fruiting body in the stem of Sakhalin fir inoculated with *Fomitiporia hartigii***
by Takehiro Yamaguchi

P-15 **Effects of snow manipulation treatments on damage to *Abies sachalinensis* seeds by soil-born fungi**
by Toshizumi Miyamoto

P-16 **Monitoring the effect of ungulates on forest regeneration in Slovenia**
by Aleš Poljanec

P-17 **Photosynthetic responses of Sakhalin fir seedlings exposed to elevated ozone: a preliminary assessment**
by Tetsuto Sugai

P-18 **Biomass partitioning, photosynthesis and root starch of Japanese fir (*Abies firma*) saplings in response to light condition**
by Tanaka Kenzo

P-19 **Effects of xylem embolism on winter survival of *Abies veitchii* shoots in an upper subalpine region of central Japan**
by Emiko Maruta

P-20 **Adaptation to freezing in evergreen leaf cells of fir (*Abies sachalinensis*)**
by Keita Endoh

P-21 **Evaluation of thermal conditions for the explanation of annual variation in the seed-cone bud production of *Abies sachalinensis***
by Takeshi Seki

P-22 **The vulnerability of silver fir populations to damage from late frosts**
by Piotr Wrzesiński

P-23 **Long-term dynamics of a wave-regenerated forest following large-scale typhoon disturbance**
by Satoshi N. Suzuki

P-24 **Seeds were the least contaminated by radiocesium in Japanese fir (*Abies firma*) in Fukushima, Japan**
by Yurika Oba

P-25 **Promising fir provenances for mitigation of climate change effects: a top-down approach in provenance testing at eco-zone level**
by Raphael Thomas Klumpp

P-26 **Evaluating the home-site advantage in *Abies sachalinensis in* Hokkaido, based on the long-term provenance trials**
by Wataru Ishizuka

P-27 **Year-to-year variation in paternal and maternal reproductive successes of Momi fir trees in Abukuma Mountains, eastern Japan**
by Masato Ohtani

P-28 **Seed production and genetic improvement of *Abies sachalinensis* for plantation forestry in Hokkaido, Japan**
by Keisuke Yano

P-29 **Advantages of using Todo fir snags for deadwood management in mixed *Abies* plantation– *Larix* plantation landscapes in Hokkaido, Japan**
by Kensuke Onodera

P-30 **From sacred to profane: the millenary silviculture of *Abies alba* from the Camaldolese monastic archives in Italy**
by Carlo Urbinati

P-31 ***Abies sachalinensis* planted forests are important habitats for understory plants**
by Nobuhiro Akashi

P-32 **Acclimation capacity of *Abies sachalinensis* seedlings to different light conditions after selection cutting**
by Masazumi Kayama

P-33 **Genetic characterization of important regional silver fir populations in the Czech Republic**
by Martin Fulín

P-34 **Evaluation of quantitative and qualitative characteristics of various species of genera *Abies* in the Czech Republic**
by Jaroslav Dostál

Open Symposium

Fir Research in Europe: Recent Achievements and Future Prospects

Speakers:

Dr. Andrej Bončina
Professor, Biotechnical Faculty, University of Ljubljana, Slovenia
Coordinator of IUFRO WP 1.01.09

Dr. Dorota Dobrowolska
Associate Professor, Forest Research Institute, Poland
Deputy Coordinator of IUFRO WP 1.01.09

Dr. Raphael Thomas Klumpp
Assistant Professor, Institute of Silviculture, University of Natural Resources and Life Science Vienna, Austria
Deputy Coordinator of IUFRO WP 1.01.09

Moderator:

Dr. Toshiaki Owari
Associate Professor, The University of Tokyo Hokkaido Forest, Japan
Deputy Coordinator of IUFRO WP 1.01.09

OS-1

Stand Dynamics of Silver Fir–European Beech Forests

Andrej Bončina

University of Ljubljana, Biotechnical Faculty, Dept. of Forestry and Renewable Forest Resources

Silver fir (*Abies alba* Mill.) grows in mixed even- or uneven-aged stands as co-dominant tree species usually in a company of Norway spruce and European beech. In some forest communities, it appears as a minor tree species. There are three main types of silver fir forests in central and south-eastern Europe: 1) mixed mountain forests on carbonate substrate in the Alps, 2) acidophilus Norway spruce-silver fir forests, and 3) mixed mountain forests on carbonate substrate outside of the Alps. A representative of the latter is silver fir–European beech forest in Dinaric region (NW Balkan). The region is characterized by an extensive forest matrix, diverse orography, mountain vegetation, long tradition of uneven-aged forestry and therefore relatively well preserved forest stands. Stand dynamics of silver fir population in the Dinaric forests is driven mainly by 1) silviculture activities, 2) ungulate browsing, 3) environmental change (SO_2 emission and climate change), and 4) natural disturbances.

Uneven-aged forestry based on natural regeneration (silver fir has rarely been planted) and mimicking of natural stand dynamics is more appropriate to maintain silver fir in the mixed Dinaric forest if compared to even-aged silviculture. Some silvicultural systems such as a plenter system favour shade tolerant silver fir "on the account" of other native tree species.

Large ungulates, especially reed deer population (*Cervus elaphus* L.) have recently become the major cause for recruitment failure of silver fir into forest stand. Absence of recruitment has already reflected in aging of silver fir population, and indicates the decline of silver fir in the next decades in the region. It seems that under high density of reed deer population, silviculture systems have a limited capacity to maintain silver fir in the mixed stands.

In the 1960s-1980s sharp decline of silver fir across the Dinaric region was evident, followed by a dramatic recovery. Results of dendrochronological methods showed that SO_2 emission explained a larger part of variability in radial growth of fir during the 20^{th} century, but climatic factors were significant, too. Decline of silver fir across the region varied noticeably in regard to orography and climate conditions.

Studies of old growth forests in the region showed that natural disturbance regime is characterized by small scale disturbances, while intermediate disturbances are rarely present - mainly caused by wind, snow or ice storm. The "freestyle" silviculture that applies elements of various uneven-aged systems seems to be appropriate way to mimic natural stand dynamics of silver fir-European beech forests.

OS-2

Structure and Regeneration of Silver Fir in Natural mixed Stands - Implication for Silviculture

Dorota Dobrowolska

Department of Forest Ecology, Forest Research Institute, Poland

Silver fir (*Abies alba* Mill.) is a large conifer that can be found in central Europe and some parts of Southern and Eastern Europe. This tree is considered an important ecological and functional balancer of European forests and a fundamental species for maintaining high biodiversity in forested ecosystems. Silver fir is mostly found in mixed stands with Norway spruce (*Picea abies*), Scots pine (*Pinus sylvestris*) or montane pine (*P. ucinata*) at the upper tree limit. At lower altitudes it competes with beech (*Fagus sylvatica*). It is very shade tolerant and can remain as a "seedling bank"under the canopy of older dominant trees for decades. It often invades deciduous forests due to its easy natural regeneration. However, silver fir may become a very rare and even extinct species in contemporary strictly protected forest reserves under current conditions influenced by humans. Its fate will depend on the management methods selected.

European forests have been affected by humans and gradually cultivated since the Neolithic Age. Silver fir forests in the Carpathians were affected by sheep and cattle grazing, litter raking, charcoal production in charcoal pits, and by patch cutting of individual trees.

Silver fir has frequently received particular attention from foresters and researchers, mainly because of fir's economic, environmental, and social significance combined with its intensive decline in the last decades and problems concerning natural regeneration. The decline was first interpreted as a periphery effect of fir's natural range. In the 1970s and 1980s widespread decline and even dieback of fir was observed in Central Europe, a phenomenon that was called "fir dieback". The phenomenon of fir decline followed by its recovery caused the creation of untypical periods, significantly different from stages and phases typical of an undisturbed development cycle. The exact causes of fir decline are still unknown. It is a complex disease, since several environmental factors apparently interact with each other, such as drought, frost, strong temperature decreases, competition, pollution, soil acidification, mineral deficiencies, inappropriate silvicultural treatments, insects, and pathogens. Decline of silver fir has occurred periodically in Europe since about 1500 both gradually and in a step-like fashion with particular stress events causing a sharp increase in the incidence of declines. However, silver fir has increased its dominance within European forests.

Fir conservation has been significantly affected by forest management systems. Fir is less competitive in areas where management systems caused rapid and major changes in forest stands (e.g. clear cutting). Fir was rarely used in plantations or for planting and seeding in artificial regeneration. Low regeneration could be related to dominant layer species composition, ungulate browsing, allelopathic phenomena or inappropriate regeneration treatments.. Irregular shelterwood or/and selection forest management have been practiced in all forest types, which should have a beneficiary impact on fir regeneration. Regeneration occurrence can also be controlled by more temporarily stable factors such as seedbed features, competition of forest floor vegetation, understory, post-dispersal seed predation, or microtopography.

Less intensive logging practices, which focus on silver fir trees of several sizes and ages, may be more desirable for the long-term management of these forests in the context of a forecasted warmer and drier climate. Forest management might take advantage of these procedures to identify and selectively cut low-vitality trees, so as to release the remaining healthy trees. Better adaptation to shelter (single tree selection) might be associated with prolonged rotation periods. Fir conservation is still a challenging task in forest management. The increasing risks due to environmental changes make fir conservation even more challenging.

OS-3

On the Gene Ecology in European Fir Species

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European forest statistics shows silver fir (*Abies alba* Mill.) as rank 11 and an area proportion of 1.5 % out of 36 European tree species which can be observed at an area proportion of more than 0.2 % (Koeble and Seufert 2001). Whilst European forestry is dominated by Scots pine (*Pinus sylvestris*: 31 %) and Norway spruce (*Picea abies*: 21 %), silver fir is found mostly mixed with beech or other broad leaved species as well as with Norway spruce in the mountains. Regionally, silver fir dominates forest stands (e.g. Val d'Aran (Spain), Beskide (Poland), Bregenz Forests (Austria)), making it a species of great economic importance for regional markets. A number of closely related species with smaller distribution areas are found in the south of Europe in the Mediterranean and in the Black Sea region (e.g. *A. cephalonica, A. cilicica, A. pinsapo* and *maroccana, A. borisii-regis, A. bornmuelleriana, A. nordmanniana*), where they occupy a variety of different habitats.

Oldest fossil records in European fir species are known from the Tertiary so that drift of the continents as well as climate oscillation (glaciation) shaped species diversity of European fir species over 65 million years. The fluctuation of the sea level in the Mediterranean Sea together with complex tectonic processes in shaping the Mediterranean basin resulted in isolation of fir populations, what may have had much more severe effects on the gene pool of European fir species than the extinction of populations by glacial ice sheets.

Recent molecular marker studies in combination with findings from fossil pollen records allow understanding the recolonization pathways of fir in Europe after last glaciation. In addition, the knowledge on fir provenances and their respective ecological amplitude was elucidated by national and international provenance test series. Hence, particular diverse *Abies alba* populations are described for refugial areas (e.g. Reggio di Calabria, Italy) and the Carpathian mountains as well as for introgression zones (e.g. Beskid mountains: Poland, Ukraine). Provenances of those regions perform best in provenance trails all over Europe and thus are recommended for afforestation in semi natural as well as in plantation forestry.

Keynotes

Speakers:

Dr. Aljos Farjon
Honorary Research Associate
Herbarium, Royal Botanic Gardens, Kew, United Kingdom

Dr. K. David Coates
Research Silviculturist
Ministry of Forests, Lands and Natural Resource Operations,
British Columbia, Canada

Dr. Masato Shibuya
Associate Professor of Silviculture
Research Faculty of Agriculture, Hokkaido University, Japan

Keynote 1

Abies: an overview of the Firs of the World

Aljos Farjon

Royal Botanic Gardens, Kew

The genus *Abies* is the second largest genus in the family Pinaceae (after *Pinus*) and, like the rest of the family save one species of pine, is confined to the Northern Hemisphere. The genus, although diverse, is more limited in its actual distribution as its climate and soil requirements are within a relatively narrow range. For these reasons it is limited both in its latitudinal range and its altitudinal range. In latitude, it does not occur at the extreme northern edge of the tree line; in altitude it is a conifer genus that occupies the middle montane zone except in its southernmost populations where this genus ascends to the limit of trees in e.g. the Himalayas and Central America. Unlike pines and spruces (*Picea*) firs (*Abies*) rarely form vast forests composed of a single species; they are most commonly a constituent of mixed forest, either all coniferous or mixed with broadleaved trees. Firs are relatively shade tolerant conifers which are able to compete with most broadleaved trees, which partly explains this mixture. The genus *Abies* has an almost equal number of species represented in Eurasia and North America and several species across the North Pacific are closely related, with 'sister species' in Asia and North America. This implies relatively recent connections across the Bering Strait that united the ancestors of these species. There is evidence for recent speciation, e.g. in the so-called Sino-Himalayan region, but also for relict species, e.g. *Abies koraiensis*, now limited to a few isolated mountains in Korea. Evidence for the relict status of the latter species comes from its extraordinary genetic variability, probably the result of isolation, which is exploited in horticulture. Europe is very poor in species diversity as a result of the confinement caused by high mountain ranges which blocked a southward retreat during the expansion of Pleistocene glaciations. These repeated events trapped many trees, causing their extinction. However, for *Abies* we can only surmise these events because the fossil record is remarkably poor.

Keynote 2

Species interactions, neighbourhood dynamics and complexity science: management options for North American *Abies* forests

K. David Coates

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The genus *Abies*, or true firs, are commonly the more shade tolerant members of mixed-species forests in temperate, montane and boreal regions of North America (NA). At higher elevations and at tree-lines, *Abies* can be the dominant tree species in mixed forests and can even form single-species forests. In western NA, the genus *Abies* is represented by amabilis fir (*Abies amabilis*) and grand fir (*Abies grandis*) in temperate coastal British Columbia (BC), Washington and Oregon, while in inland mixed-conifer forests of the western United States, noble fir (*Abies procera*), white fir (*Abies concolor*) and California red fir (*Abies magnifica*) are found at medium and higher elevations. Subalpine fir (*Abies lasiocarpa*) is common in subalpine and boreal forests of the west. Balsam fir (*Abies balsamea*) is abundant in mixed conifer-broadleaved forests across central and eastern Canada and the eastern US. Lastly, Fraser fir (*Abies fraseri*) is a small tree with a limited distribution in the southern Appalachian mountains of the southeast US.

Foresters charged with managing forests with *Abies* species are being called upon to implement a wider variety of management systems to meet broader objectives such as sustaining the function and dynamics of ecosystems, maintaining ecosystem diversity and resilience or protecting sensitive species, while providing for a variety of ecosystem services of value to humanity. This will require moving toward a more flexible multi-scale perspective that considers tree- stand- and landscape-scale processes and their interactions. Science now views forest ecosystems as non-equilibrium social-ecological systems with interactions and feedbacks among climate, management and disturbance agents. *Abies* species and the multi-species forests they often inhabit do not lend themselves to the agricultural model of even-aged plantation forestry. Because of their high tolerance of shade, and other demographic attributes, *Abies* are well suited to mixed-species structurally complex stand management. Fir forests are heterogeneous, highly dynamic with biotic and abiotic elements that interact across different levels of organization with various feedback loops. Such forests are subject to ongoing change in conditions as the climate warms, and state shifts can be anticipated in response to threshold changes in external or internal drivers. In northern BC, contrary to expectations, we have found that subalpine fir in mid-rotation plantations has experienced less damage from recent warming trends than the more commonly managed lodgepole pine.

It is imperative that foresters constantly improve our approach to the science and practice of forest management. Dynamic change will be the rule rather than the exception. Forest managers must consider and evaluate the short- and long-term viability of specific practices in *Abies* forests within a framework that minimizes risk, reduces the chance of undesirable future outcomes and captures potential opportunities by working with interactions among species. Protection and production of more diverse forest values demands consideration of the fine-scale variability found within mixed-species *Abies* forests and an understanding of the spatial and temporal response of *Abies* species to manipulation. *Abies* management must focus on maintaining critical processes in mixed forests and on how tree populations and ecosystem processes interact to affect stand dynamics. I will suggest new approaches for silviculture that will allow foresters to better incorporate complexity into their management decisions for *Abies* forests.

Keynote 3

Abies species in Japan, and natural stands and plantations of *A. sachalinensis* in Hokkaido

Masato Shibuya

Research Faculty of Agriculture, Hokkaido University

Japanese forests extend from the sub-tropical zone to the transition zone between the cool-temperate and boreal zones. In southern Japan, evergreen broadleaved trees dominate, while deciduous broadleaved trees and conifers dominate in northern Japan. Five *Abies* tree species are native to Japan: *A. firma*, *A. mariesii*, *A. veitchii*, *A. homolepis* and *A. sachalinensis*. The four species other than *A. sachalinensis* are distributed on Honshu, Shikoku and Kyushu Islands, while *A. sachalinensis* occurs in Hokkaido (Fig. 1). *A. firma* has the largest distribution among Japanese *Abies* species, and *A. sachalinensis* occurs throughout Hokkaido at altitudes up to 1000 m. The other species occur mainly in subalpine zone. Japanese *Abies* species occur in mixed stands. Natural forests in central Japan consisting of *A. veitchii* and *A. mariesii* have peculiar stand dynamics involving a wave-regeneration. In winter in the Tohoku region, in northeastern Japan, unique snow-ice 'monsters' develop (Photo. 1). While *A. sachalinensis* is an important plantation species in Hokkaido, the other species are generally not used for plantations.

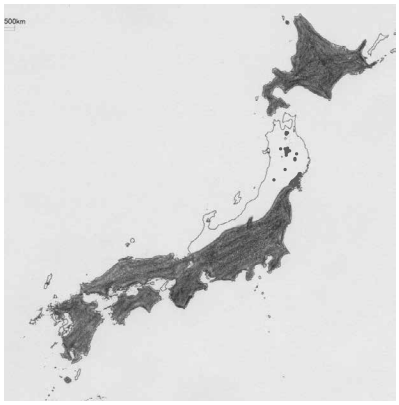

Fig. 1. The distribution of *Abies* species in Japan.

Photo. 1. A snow-ice 'monster' involving *Abies* trees.

In Sapporo, for 1981–2010, annual mean temperature was 8.9 °C and mean precipitation was 1107 mm. The monthly mean temperature ranges from -3.6 to 22.3 °C. The forest zone in Hokkaido is a transition zone between cool-temperate and boreal zones, and the major forest type comprises mixed stands of deciduous broadleaved trees and evergreen conifers. *Abies sachalinensis* is an important species in natural forests and plantations in Hokkaido, and attains 60–70 cm in DBH and 30-35 m in height. In natural forests, *A. sachalinensis* lives 150-200 years. *A. sachalinensis* is a important member of natural mixed stands. The stocked volume of *A. sachalinensis* accounts for 29 % of the total volume in Hokkaido. *A. sachalinensis* is a shade-tolerant species and its growth in natural stands depends on canopy gaps. In Hokkaido, there are about 771,000 ha of *A. sachalinensis* plantations, which accounts for 52 % of the total plantation area. The typical stand age at the final cutting of *A. sachalinensis* plantations is 50–60 years. The wood of *A. sachalinensis* is used for construction, paper, plywood and laminated wood. In Hokkaido, root and butt rot damage are serious problems in *Abies* plantations and 26 % of the trees are rotted. More than 10 root and butt rot fungi occur in *Abies* plantations in Hokkaido, and cause large economical losses to forest owners. However, no disease control is currently available in Hokkaido.

Oral Presentation

S1-1

Spatio-Temporal Distribution and Ecology of *Abies* in the Korean Peninsula

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Time-spatial distribution of *Abies* spp. and its future in connection with climate change in the Korean Peninsula is discussed. Out of 30 native Korean conifers, *Abies* contains three species, *i.e., A. holophylla*, *A. nephrolepis* and *A. koreana*. *A. holophylla* is common on the montane belts from at the elevation from 100 to 1,500m a.s.l., *A. nephrolepis* grows nationwide at the subalpine belts between 700 to 2,200m a.s.l., and Korean endemic *A. koreana* confined its distribution at southern subalpine belts between 1,000 to 1,900m a.s.l. from Sokrisan(36°32′ N) to Hallasan(33°25′ N). *A. koreana* with actual area of occupancy of *ca*. 12 km² at the distances between each location range from 40 to 250 km and are likely to be too great to allow for effective gene flow.

Fossils of *Abies* in Korea occurred from the Miocene period of Tertiary, Pleistocene and Holocene of Quaternary, Cenozoic Era. Nationwide continuous presence of *Abies* fossils, especially its extensive range during Quaternary might closely related to climatic deterioration. Current disjunct range of *Abies koreana* at southern subalpine belts might be the result of long term isolation and speciation from the northern *Abies nephrolepis*. During the Last Glacial Maximum, range of *Abies nephrolepis*, might have expanded toward south and downward in search of glacial refugia, when the temperature was –6 to –7 °C colder than today. Due to the separation and isolation of *Abies nephrolepis* to new local southern subalpine environments and habitats, as the climate ameliorated since the Holocene, the isolated community eventually adapted to the new post-glacial refugia and later became an endemic species, *Abies koreana*. Regional decline of *Abies koreana* since 1980's might most probably the results of complex interactions between multiple environmental factors, such as global warming and inter-species competition with temperate tree species.

S1-2

Spatial patterns of fading *Abies alba* in Western Carpathians, Europe

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The decline of *Abies alba* Mill. (fir) in natural fir-beech forests in Europe has fascinated scientists for over a century. During this period, *Fagus sylvatica* L. (beech) became the dominant species in this forest type.

We hypothesized that (i) the success of beech over fir is significantly connected with the fact that beech suffers less than fir from the presence of conspecific neighbours; that (ii) shade tolerance is not a factor which favours beech over fir; and that (iii) because treethrow mounds create patches with a significantly reduced proportion of litter, fir trees will reveal a stronger positive association with treethrow mounds than beech trees.

We investigated these hypotheses by means of tree spatial pattern analysis and inventories of natural regeneration. Eight rectangular plots (2–8 ha) were analysed in mountain fir-beech forests of the Outer Western Carpathians, Czech Republic. Various types of the pair correlation function and L function were used to describe the tree density variability of trees with DBH ≥ 10 cm. The analyses were carried out on datasets from the 1970s, 1990s and 2000s.

Our results suggest that negative density dependence is not responsible for the current decline of fir. While fir recruits were positively connected to other fir individuals, beech recruits showed the exact opposite. Moreover the mean distance between inventory plots with occurrence of fir regeneration (height 0.1-1.3m) and adult fir trees (DBH ≥ 10 cm) is significantly shorter then distance between plots with beech regeneration and adult beech trees.

It seems that a higher shade tolerance of the advanced regeneration could be one of the factors which favour beech over fir. Fir showed an apparent tendency towards a positive spatial association between new recruits and standing dead trees up to 10 m. By contrast, beech demonstrated no spatial association or a tendency towards a negative spatial association between recruits and standing dead trees.

Finally it is evident that fir trees have a markedly stronger positive association to mounds than beech trees. Our results suggest that under current conditions in European non-intervention stands fir has very limited abilities to successfully coexist with the dominant beech.

S1-3

Phylogeography and evolution of the Mediterranean firs

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Several molecular phylogenetic studies were conducted for *Abies*. All of these studies included either a limited set of species or used only data from few markers of a single genome, either from chloroplast genome, nuclear ribosomal or mitochondrial DNA. Here we present the complete molecular phylogeography of all the Mediterranean firs using Next-generation sequencing (RADseq). The application of NGS by RADseq method in this study has provided great information for the relationship and evolution of the *Abies* species in the Mediterranean. The different analyses confirm species delimitations and produce a well-supported phylogenetic tree. The evolutionary history of the Mediterranean firs is also discussed in the context of the paleogeological and postglacial history of the region.

S1-4

Phylogenetic relationships and taxonomic diversity of genus *Abies* inferred from nuclear and cytoplasmic DNA

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In order to study the phylogeny, evolutionary history and molecular systematics of genus *Abies*, we performed a phylogenetic reconstruction of 42 fir taxa representing main lineages of the evolution of the genus. Comparisons were made among three genomic regions: paternally inherited chloroplast DNA (cpDNA), maternally inherited mitochondrial (mtDNA) and bipaternally inherited nuclear DNA (nrDNA). Five cpDNA fragments (total length 5659 bp) and three mtDNA fragments (total length 4009 bp) were sequenced in 76 samples of 42 fir taxa. Nucleotide sequences of ten single copy nuclear genes (total length 5200 bp) were obtained for 65 samples of 40 fir taxa. For the AFLP we used seven pairs of selective primers, 84 samples of 39 taxa were genotyped for 553 polymorphic loci.

A species tree, derived from a set of nuclear genes, was congruent with AFLP-based neighbor-joining tree, although it has a higher resolution. Phylogenetic tree of 34 mitotypes of fir species revealed two major clades of mitotypes, American and Eurasian, and several subclades. While analyzing the data of phylogenetic reconstruction, the most likely biogeographic scenarios were offered. Calibrations of the divergence times were based on paleobotanical data and on the estimation of the mutation rate. Conflicts among nuclear and cytoplasmic phylogenies were analyzed.

The revealed variability in nr-, cp-, and mtDNA can be used for the taxonomic identification of specific fir samples in nature and culture, as well as to detect spontaneous and artificial hybrids. Most fir species have been characterized with species-specific mutations and their combinations, allowing the precise discrimination of specimens of a particular taxon. A comparison of molecular data with the traditional taxonomy of the genus was discussed. Compared to cp- and mtDNA data, nuclear markers better correspond to taxonomic classifications, based on morphological characters. However, there were some serious contradictions concerning section classification and recognition of species status. We confirmed the species rank and identified taxonomic position of two endemic firs – *A. gracilis* Kom. (Kamchatka) and *A. semenovii* B. Fedtsch. (W. Tien-Shan). This study was supported by the Russian Foundation for Basic Research, grant no. 14-04-00848a.

S2-1

Opportunist, generalist or specialist – fir regeneration strategies and microsite preferences in the Carpathian mixed beech forests.

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We aimed at elucidating the differences in regeneration strategies of silver fir and other two main species in mixed beech forests of the Western Carpathians (Poland), i.e. European beech and Norway spruce. We analyzed seedling demographic processes and growth in relation to: i) two main microsites – forest floor vs. coarse woody debris (CWD), ii) different properties of CWD. Additionally, we compared composition of tree regeneration in gaps and under forest canopy. We tracked survival and growth of all seedlings and germinants growing on CWD and forest floor for 5 years. Moreover, we analyzed the effects of CWD properties (decay class, form, species and diameter) on germinant and seedling annual counts, survival and seedling growth rates for 7 years in two old-growth stands. To check for the differences in gap-dependency between species in different life-stages, 38 gaps were sampled in two stands.

Fir had similar densities on forest floor and CWD, while spruce strongly preferred CWD for its establishment and survival. Beech showed preferences for forest floor but it was also successful in utilizing CWD. We found some demographic differences between species relative to CWD properties. In general, beech and spruce showed similarity in their response to one substrate over the other in the patterns of density, survival and growth, while fir did not respond at all or responded differently. Fir had slight preferences toward forest stand, while spruce generally preferred gaps for its regeneration and beech was equally abundant in gaps and under forest canopy in all life-stages. The results showed that fir behaves more like generalist in establishment and growth on various substrates compared with beech which seems to be very opportunistic in its regeneration strategies and spruce which is gap and CWD specialist.

S2-2

An individual tree growth model for Todo fir (*Abies sachalinensis* (Fr. Schmidt) Masters) in Hokkaido, northern Japan

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Although Todo fir (*Abies sachalinensis* (Fr. Schmidt) Masters) plantations are very common in Hokkaido, northern Japan, there are no widely applicable individual tree growth models that are useful for plantation management, because environmental conditions vary on the island and are easily influenced by a host of other factors.

In this study, we developed an individual diameter growth model for Todo fir plantations based on data obtained from 100 permanent plots (size: 30 m × 31 m) located in various regions in Hokkaido. The trunk diameter and tree height of all individuals within the plots were measured in 2010 and 2012. The model incorporated the initial diameter, stand age, site index, and basal area, which appeared to affect the diameter growth. The results of the analyses of the effects of the physical environment on individual diameter growth and a model for the trunk diameter–tree height relationship are presented.

S2-3

Mortality Functions for *Abies balsamea* and *Abies lasiocarpa* for Western North America in Relation to Tree size, Stand Competition and Climate

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The objective of this study was to develop models of survival probability for Balsam fir (*Abies balsamea* (L.) Mill.) and Subalpine fir (*Abies lasiocarpa* (Hook.) Nutt.) using data from an extensive network of permanent sample plots (PSPs) in western Canada and Alaska (USA). 10 % of the original dataset was randomly selected and later used for the validation of the mortality functions. Logistic models for Balsam fir were developed using information on tree mortality from 1,657 PSPs and included 38,395 trees, and for Subalpine fir the number of PSPs was 1,127 and included 32,430 trees. For each PSP, data on tree size, stand characteristics (e.g. competition estimates), and climate were also available. The logistic model developed for Balsam fir included: tree size (i.e. DBH), sum of basal area of trees larger than the subject tree within the PSP, and a climate variable (i.e. autumn precipitation). The AUC value (i.e. area under the curve) based on the validation data equals 0.85. For Subalpine fir the model developed included tree size (i.e. DBH), density of conifers within the PSP larger than the subject tree, and a climate variable (i.e. winter precipitation). The AUC value based on the validation data equals 0.83. These models provide a better understanding of mortality of these two species in this region and these predictive equations will soon be incorporated into the Mixedwood Growth Model (MGM - University of Alberta, Canada).

S2-4

Incidence and factors influencing root and butt rot in Todo fir stands in Hokkaido, Japan.

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Todo fir (*Abies sachalinensis*) is the dominant tree species in natural forests and is also the principal species grown in commercial plantations in Hokkaido. More than 10 species of root and butt rotting fungi including *Heterobasidion parviporum* and *Armillaria ostoyae* were recorded on living Todo fir and approximately 50–55% of mature Todo fir are damaged by root and butt rots in natural forests in Hokkaido. To obtain the first data on the incidence of root and butt rot damage in stands of the species throughout Hokkaido, and to develop models which are able to predict the disease incidence and the decay sizes at stump height of each trees in a given stand, we examined 13,288 recently felled stumps in 232 plots in 224 first-rotation Todo fir plantations. We found evidence of rot in 3,493 (35.7%) of the cut stumps, with incidence of disease ranging from 0% to 94.0% among sites, and diameters of affected wood at the stump surfaces ranging from approximately 1 to 59.5 cm. All wounded Todo firs (mostly injured by forestry operations probably) were decayed, and 29.8% of the recorded cases of decay were apparently initiated from wounds. The stepwise logistic regression models constructed to predict the incidence and the sizes of the decay in unwounded trees in each of the stands showed that stand age and landform had significant effect to decay incidence and nine variables including stand age, landform, altitude and some climatic factors such as warmth index significantly influenced decay sizes. A corresponding model indicated that stand age, landform and relative position on the slope had significant effects to the occurrence of wounded trees. Wound decay should be minimized by silvicultural options, and further studies are needed to control the disease incidence of unwounded trees and spread of decay in infected trees that appears to be regulated more by environmental conditions than human activities.

S3-1

Balsam fir growth and forest regeneration under increased browsing pressure from moose

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Over the last 2 decades, large herbivore populations increased dramatically in several regions around the world, modifying forest composition and structure in the process. Chronic and intense browsing may stop the growth of preferred juvenile plant for several years delaying their recruitment in the pole stage. Still little is known about the amplitude of this browsing delay on the recruitment and its impact on the forest regeneration. The objective of this project is to measure long-term effect of browsing by moose (*Alces alces*) on juvenile balsam fir (*Abies Balsamea*) to estimate the recruitment delay in balsam fir stand, especially within winter moose yard. We dated stem defects of 150 balsam fir stems lower than 3 m in order to reconstruct their browsing history and their internodal growth patterns with a dendroarchitecture approach. We associated browsing histories and growth patterns with a random forest typology and isolated growth form characteristics linking to the browsing delay. On the field, we surveyed the browsing typology proportions of 15 moose winter yards and used the associated growth patterns to estimate a fir recruitment delay. Those results will be compared to moose population abundance data collected over the last 2 decades from aerial surveys and hunting statistics. The dendroarchitectural approach may improve traditional browse survey by estimating long term browsing impact on wood production, and could be integrated into the forest survey to support sustainable forestry practices integrating disturbance by herbivores.

S3-2

Influence of large ungulates on silver fir-European beech forest vegetation: comparison between fenced and unfenced sites

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Browsing by ungulates may significantly govern regeneration and recruitment of palatable tree species such as *Abies alba*. The magnitude of browsing pressure can be studied by comparing vegetation in unfenced and fenced areas where the impact of ungulates is completely eliminated. We aimed to compare forest vegetation in fenced and unfenced areas to reveal the impact of ungulates on establishment and growth of different species. In the study, tree species regeneration (dbh<10 cm) and understory plant species composition were compared between fenced (n=238 plots, 16 m^2 each) and unfenced areas (n=86 plots, 16 m^2 each) in 6 sites of Dinaric fir-Norway spruce-European beech forests (150 km^2) in Slovenia, characterized by high density of red deer (*Cervus elaphus* L., ≈7/km^2). Vegetation was surveyed in forest stands under regeneration, 6-35 years after the fencing. A bit surprisingly, the density of regeneration was higher in unfenced (58,234/ha) compared to fenced areas (46,226/ha). However, in the fenced area regeneration was higher, and the proportion of the main species differed significantly from the one outside the fence: *Fagus sylvatica* occupied 61.4 % and 66.7 %, *A.alba* 26.8 % and 7.6 %, *Acer pseudoplatanus* 8.8 % and 20.4 %, and *Ulmus glabra* 2.3 % and 4.1 % in fenced and unfenced areas, respectively. Some plant species (e.g. *Rubus hirtus, Atropa belladonna*) were significantly more abundant in the fenced sites and some (e.g. *Brachypodium sylvaticum*) in the unfenced area. The longer the period after fencing, the higher was the proportion of silver fir in the taller height classes. In the fence, 607 silver fir/ha were taller than 50 cm, whereas out of the fence, only 8 silver fir/ha survived in the height class 50-90 cm and no silver fir was taller than 90 cm. Current browsing pressure no longer allows survivorship of silver fir in the Dinaric forests; only management of red deer may open windows for silver fir overgrowth into forest stands.

S3-3

Relative contributions of plant competition and browsing by white-tailed deer on the performance of planted balsam fir

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Balsam fir (*Abies balsamea*) is one of the most common coniferous tree species in North America's boreal forest. Population increase of large herbivores in various regions has however led to regeneration failures for this species. On Anticosti Island (Quebec, Canada), it is known that chronic browsing by white-tailed deer (*Odocoileus virginianus*) prevents the natural recruitment of native balsam fir but few studies have investigated the common role of top-down and bottom-up processes. Experimental plantations have therefore been established in 2008-2009 to determine the roles of the control by resources and consumption by deer on the performance and survival of planted balsam fir seedlings. Using a network of exclosures, we assessed how deer modifies the expected effects of seedling stock size, soil preparation and mechanical release while influencing both seedlings and surrounding vegetation. Our results suggest that a controlled deer density around 20 deer/km^2, although causing direct damage to seedlings, can reduce competitive interactions with a beneficial impact on balsam fir's survival. White-tailed deer reduced the height of deciduous trees, thus promoting conditions of full light. Our results highlight how herbivores mediate interactions among plants and provide a concrete assessment of the effectiveness of silvicultural treatments to promote seedling growth and survival.

S3-4

Does browsing resilience of saplings differ among provenances? A genecological study with simulated browsing

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Due to long-term selection processes, autochthonous tree populations are well adapted to their local environments. Consequently, they exhibit genetic variation among provenances that might also induce provenance-specific reactions of trees to ungulate browsing. In an extensive genecological common garden experiment, we investigated quantitative genetic variation within and among provenances of *Abies alba, Picea abies*, and *Fagus sylvatica*, three important European tree species. Each species was represented by approx. 90 autochthonous provenances, covering the species' ecological range in Switzerland (e.g., elevations from 330 until 2100 m a.s.l.). In 2012, 4000 seedlings per species were planted in a single tree random plot design in an open-land study site. Growth and phenology were measured in 2013 and 2014. In spring 2015, the saplings were clipped with three intensities (heavy, slight and no clipping). Growth reactions were assessed one and two growing seasons after treatment, and provenance differences were related to environmental variables of seed sources.

Seedling traits before clipping showed considerable genetic variation among provenances. Thereby, provenance differentiation and associations with the environment were stronger for *P. abies* and *F. sylvatica* than for *A. alba*. Still, *A. alba* from low elevation provenances grew significantly faster than those from high elevations. Analyzing sapling traits measured after clipping will allow identifying potential among-provenance differences in their growth reaction after clipping. This will lead to a better understanding of a tree species' reaction to leader shoot disturbances such as those caused by herbivory, and may allow to identify provenances with high sapling resilience to browsing.

S4-1

Disturbance history of old-growth mixed beech-fir-spruce forests in Western Carpathians.

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The frequency and severity of disturbances in old-growth mixed forests in Western Carpathians was analyzed using boundary-line method. The study plots (1 ha each) were located in strictly protected areas of three Polish National Parks: Babia Gora, Tatra Mountains and Gorce. In every plot cores were extracted from 30 trees of three main tree species: *Fagus sylvatica*, *Abies alba* and *Picea abies*. In total 270 cores were measured. The oldest beeches and firs were over 300 years old, while the oldest spruce trees did not exceeded 275 years. Significant differences in age structures of beech, fir and spruce were found in all three plots. There were no signs of stand-replacing disturbances in any of the three plots during last 200-250 years. The disturbance chronologies showed a very low percentage of major releases in all three plots and the frequency of moderate disturbances varied over time. Many trees showed the signs of significant and synchronous growth release in last 20-30 years. This peak in disturbance chronology was the result of high frequency of low-severity disturbances, initiated by dieback of several single fir trees in the second half of XX century, resulting in the creation of many small gaps.

Although there was no large scale disturbances in the past, we did noticed a wind throw in 2015 in Tatra Mountains, which blew down one-third of the stands volume, mostly big old firs. That last disturbance changed significantly the stands structure and decreased the share of fir in the forest stand.

S4-2

Increased mortality of *Abies sachalinensis* following a wind-disturbance in a natural mixed forest

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The major natural disturbance agent of northern Japanese forests is strong winds. Canopy gaps induced by a disturbance are responsible for subsequent recovery of the stand (i.e. enhancement of growth and recruitment), while there is also a possibility that a sudden change in stand structure, involving significant microclimatic alterations, cause further stand degradation. We therefore examined a hypothesis that there are indirect and delayed negative effects of a wind disturbance on demography of a fir (*Abies sachalinensis*)-dominated natural mixed forest. In a 3-ha study stand, all the trees with diameter at breast height larger than 10 cm were censused for 8-years following a severe wind-disturbance (caused by Typhoon Songda in 2004). We found total supply of dead trees during the post-disturbance period (3.1m^2/ha) was equivalent to the extent at the strong wind (3.4m^2/ha). The mortality of fir was generally high in larger individuals. In the period immediately after the disturbance (1 or 2 years later) dead fir trees frequently presented with uprooting form (35%) despite there being no record of strong winds, suggesting that physical influence of the disturbance was still left. In addition, these dead trees were spatially aggregated; showing positive relation with amount of surrounding trees died at the strong wind. On the other hand, trees died 3-8 years later distributed at random, and all of them showed growth reduction after 2004. We conclude that a strong wind-disturbance is not a transient event; it can influence stand dynamics for a long-term, in which possible causes of deaths change gradually from physical damages to physiological stresses.

S4-3

Is *Abies alba* more susceptible to ice damage as other tree species in mixed forests of Central Europe?

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In mountainous areas of Central Europe wind, snow and ice are the main abiotic agents of natural disturbances. In 2014 an extensive ice storm in Slovenia damaged ≈9.3 mio m^3 of timber on the forest area of more than 600 km^2, where mixed stands of *Fagus sylvatica*, *Picea abies, Abies alba, Pinus sylvestris*, *Acer pseudoplatanus* and other tree species prevail. The susceptibility of tree species to wind and snow damages is quite well known, while that to ice damages has been poorly investigated. To examine the resistance of main tree species to ice storm, we analyzed data from 983 permanent sampling plots, on which 17,786 trees were analyzed in 2013, and re-analyzed in 2014 immediately after the ice storm. Damage status of each tree was described by one of four categories (1, no damage; 2, minor; 3, considerable, and 4 major damage), while damage type was evaluated in a subsample of trees on 83 plots. Considering the proportion of damaged trees *Abies alba* was ranked the last among the 13 main tree species (groups); 10.7% of all firs were damaged (ranked 1st *P.sylvestris* 43%). In *A.alba* crown damage was the main type of damages, while only negligible proportion of fracturing or uprooting was registered; the latter were, however, very frequent for *F.sylvatica* and other broadleaves. Binary logistic regression showed that *A.alba* has lower probability to be damaged by ice storm compared to other tree species. All these suggested that *A.alba* is more resistant to ice storm compared to other main species which is promising for its conservation and management.

S4-4

Differentiated impact of climate and soil on primary and secondary growth of *Abies alba* Mill.

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The objective of this work was to determine environmental drivers of primary and secondary growth of silver fir (*Abies alba* Mill.) at the decade scale. We aimed to evaluate the respective importance of nutritional and water resources, climate and inter-specific competition on these two dimensions of the growth. For this purpose, 143 plots were carried out in the Vosges Mountains (northeastern France), using a stratified sampling design according to stand composition, elevation and nutritional status of soils. All of the stands selected were mature, even-aged, pure and mixed silver fir stands, with *Fagus sylvatica*, *Picea abies, Pinus sylvestris, Quercus petraea* and *Acer pseudoplatanus* as co-existing tree species. Dendrometric, climatic and soil variables were measured for each plot, and three trees of silver fir were core sampled. Cores were then analyzed using standard dendrochronological methods. For each plot, a site index (*SI*) and a radial index (*RI*) covering 100 years were calculated, independent of tree age, providing dominant fir height and mean radial growth data, respectively. Relationships between *SI* and *RI* and ecological factors and stand composition descriptors were analyzed using multiple-regression analyses and linear mixed-effects models, respectively.

Our study highlighted the fact that the relationship between environmental factors and height growth is different from the relationship between environmental factors and radial growth. Height growth is strongly correlated with climatic variables (elevation, aspect, winter temperature) and nutritional factors (soil acidity, aluminum toxicity, nitrogen). Moreover, spring water balance and water supply (related to topography conditions) showed a positive effect on the site index at low elevations. On the other hand, climatic effects on radial growth were weak or not significant, although the effect of water storage capacity and topographic position were revealed to be important. Moreover, there are significant and differentiated effects on silver fir growth depending on tree species composition: for example, there was an enhancing effect of high silver fir growth as a result of conifer stocking, whereas radial growth decreased with *Picea abies* presence. This result suggests important competition for light, resulting in silver fir changes in carbohydrates allocation from secondary to primary growth. These differentiated ecological patterns between height and radial growth produce a change in tree shapes with environmental conditions, which invalidate Eichhorn's rule (1904) that states that homothetic changes between primary and secondary growth occur with the change in site fertility. This invalidation should lead to the replacement of the use of site index parameter with that of direct environmental variables in stand growth models.

S4-5

Disentangling the effect of climatic and genetic factors contributing to *Abies alba* Mill. tree-ring growth variation along the Italian peninsula

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Silver fir (*Abies alba* Mill.) is an indigenous tree species present at several central and southern European mountain ranges. Its fragmented distribution along the Italian peninsula, where climatic conditions are expected to markedly change, brought both population geneticists and dendrochronologists to investigate the adaptive responses of silver fir in terms of growth dynamics. We used a dataset based on 62 silver fir site chronologies, built on about 1300 trees, that covers the entire distribution range of fir in Italy. Half of the sites were also genetically characterized by nuclear and chloroplast microsatellite markers. The climatic dataset includes a specific selection records (temperature and precipitation) of meteorological stations located within the potential distribution area of the species. Principal component analysis of the tree-ring width chronologies and of climate-growth correlation functions were applied: i) to extract common variability in annual radial growth among the chronologies and climate zones, and to ii) assess the climate-growth relationships of site chronologies. Dendrochronological and climatic responses reveal a clear distinction between the western and the eastern sectors of the Alps. In the Apennines, the northern sites are similar to the eastern Alps sites, and differ from the central and southern ones. These results were generally consistent with the main biogeographical overview obtained through clustering of genetic data, with the noteworthy exception of the central Apennines populations, showing genetic similarity with northern Apennines ones. Despite the highly fragmented distribution of fir in Italy, genetic drift appears having eroded neither their genetic variation nor the genetic signature of post-glacial recolonization dynamics on their spatial genetic structure. Fir sensitivity to climate may result in distinct spatial responses reflecting the complexity of the Mediterranean climate, with marked differences between the various sector of the study area. These results suggest the combined effect of climate and genetic population structure in explaining the different growth responses at national scale.

S5-1

Characterizing *Abies sachalinensis* among plantation species in Japan

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Todo-matsu, *Abies sachalinensis*, is one of leading plantation species in Hokkaido, Japan, together with *Larix kaempferi*. *A. sachalinesis* is native in Hokkaido and have been a main target species for the forestry of Hokkaido. The timber resource had been from natural forests historically. Today, however, almost all conifer wood production in Hokkaido is from plantation forests as well as in other places in Japan. *A. sachalinensis* is employed in Hokkaido for plantation forestry but not in other place in Japan, where *Cryptomeria japonica* and *Chamaecyparis obtusa* are mainly used.

In this paper the author reviews characteristics of *A. sachalinensis* as a plantation species, especially in terms of wood property / quality. In comparison to *Picea jezoensis*, another main native conifer in Hokkaido, *A. sachalinesis* can be easier in nursery practice and much better growth in plantations. The wood of *A. sachalinensis* is less dense, less stiff, easier to process and better in grain spirality than *L. kaempferi*, the competitor in plantation forestry in Hokkaido. There are two serious defects of *A. sachalinensis* in wood utilization, namely, heartrot and wetwood.

Through the viewpoint in this review, the improvement direction of *A. sachalinensis* should become apparent. The author will discuss the future perspective in genetic improvement by breeding programs for this important species for the sustainable forestry production in Hokkaido.

S5-2

An Analysis to Maximize Todo fir Profitability through Optimal Silviculture System Selection under Economic and Site Condition Uncertainties

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Due to low timber prices and high operational costs, there is a lack of financial incentives to practice sound forest management in Japan. This has resulted in increasing the area of unmanaged and unthinned plantation forests. Maximizing forest profitability is therefore important from both economic and environmental perspectives. In Hokkaido, northern Japan, forest managers can gain benefits through optimizing profits and maximizing profitability of Todo fir (*Abies sachalinensis*) plantations, which are widely distributed in the region. This study presents an analytical method to estimate forestry profitability based on economic and forest stand variables. A contribution index analysis identified factors that had a significant impact on profitability of target tree species. Two primary factors that affected profitability represented by the soil expectation value were timber and biomass prices and wood quality (i.e., rot incidence). The effects were quantified and visualized in three-dimensional solution graphic. In a scenario in which the rotation length was relatively low, leading to low profitability, but high suitability, the economic and biological uncertainties did not have much effect on total profitability. On the other hand, in a scenario with high rot incidence and biomass demands, it was vital to select the optimal rotation length as even small deviation had a significant impact on profitability. Our results provided guidelines on how to increase profitability and timber production by controlling wood quality and stand density through suitable silviculture system selection. The method presented in this study can be further applied to risk management by estimating the effects of external uncertainty variables on silviculture systems.

S5-3

Short-term effects of cleaning-respacings in a silver fir-dominated stand

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The paper deals with early silviculture of silver fir (*Abies alba* Mill.), a major softwood species in Romania, where it covers about 300,000 ha. In this respect, three research and demonstration plots (RDP1, RDP2, and RDP3), silver fir-dominated (76-85% of basal area) were established in a 25-year old stand in May 2012. In RDP1 and RDP2, cleaning-respacings with different intensities were carried out while RDP3 was kept as control. In all plots, *potential final crop trees* were selected based on *vigor-quality-spacing* criteria. The main characteristics of plots after the interventions performed in 2012 were as follows:

- Stocking: 1,471 trees ha^{-1} (RDP2), 3,111 trees ha^{-1} (RDP1), and 10,032 trees ha^{-1} (RDP3);
- Basal area: 11.84 sq.m ha^{-1} (RPD2), 20.11 sq.m ha^{-1} (RDP1), and 31.65 sq.m ha^{-1} (RDP3);
- Mean diameter of silver fir trees: 5.60 cm (RDP3), 8.58 cm (RDP1), and 10.19 cm (RDP2).
- Mean crown diameter of silver fir trees: 164 cm (RDP1) and 200 cm (RDP2).

The measurements performed in November 2015 confirmed the quick and positive reaction of silver fir trees to cleaning-respacing. The best results in terms of diameter increment (2012-2015) were shown by silver fir trees in RDP2 (2.98 cm, 29.24%); the same results were shown by the same species in RDP2 in terms of basal area increment (5.96 sq.m ha^{-1}, 65.86%) and increment of mean crown diameter (86 cm, 43.00%). A potential important problem encountered solely in RDP2 was the occurrence of epicormic branches on 65.79% of silver fir trees, regardless their dbh or crown sizes, with an average length of 7 cm (range 2-20 cm).

S5-4

Maintaining biodiversity in subalpine fir (*Abies lasiocarpa*) forests managed for wood production

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Subalpine fir (*Abies lasiocarpa*) is the dominant tree at high elevations and in many old growth forests of northwestern British Columbia, Canada. This tree is disliked by the forest industry and was usually replaced by planting lodgepole pine (*Pinus contorta*) and hybrid white spruce (*Picea glauca* x *engelmannii*) after harvest. This practice is changing as foresters actively manage for a wider array of ecosystem services. As an example, we examine public forests in the Bulkley Timber Supply Area of northwest British Columbia (55°N, 127°W) that have been managed for wood production for ~50 years. We summarize three recent projects that seek to maintain, monitor and restore the biodiversity of subalpine fir-dominated forests. These projects include: (1) monitoring forest retention practices across a range of stand to landscape scales using forest stand structure, breeding bird communities and epiphytic lichen communities as biodiversity indicators; (2) using prescribed fire to enhance wild berry production and grizzly bear habitat after logging of old growth subalpine fir; (3) restoring an endangered keystone tree species (*Pinus albicaulis*) to enhance diversity and wildlife habitat in high elevation forests otherwise dominated by subalpine fir. Old growth subalpine fir forests are structurally diverse with abundant dead wood, but generally support lower plant and animal diversity than the younger mixed-species stands (*Pinus, Picea, Populus, Betula, Abies*) that resulted from wildfires. Yet, subalpine fir forests provide habitat for a subgroup of species that tolerate less disturbance or human presence and require continuous tracts of older forest (caribou, wolverine, grizzly bear, certain bird species and communities, arboreal lichens, liverworts). Such tracts are fragmented as logging extends into remote and higher elevation valleys. At the same time, important features of wildfire-origin stands (e.g, abundant trembling aspen, wild berries, whitebark pine) are disappearing from stands managed for wood production. In the Bulkley Timber Supply Area each of three major logging companies has taken a slightly different approach to biodiversity management and this variety of approaches provides both learning opportunities and the benefit of diversity, but innovation is still needed. Current practices in subalpine fir forests can be adapted to (1) safeguard remaining contiguous tracts of old forest; (2) better retain and more quickly restore threatened attributes of old forests during and after logging; and (3) reintroduce fire into the landscape.

S5-5

Monks and forests in the northern Italian Apennines: legacies of historical land-use on present forest structure and processes

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This study was carried out in the "Foreste Casentinesi, Monte Falterona, Campigna" National Park between Arno and Tevere watersheds (Italy).

We compared forest structure, quantity and quality of coarse woody debris and regeneration in a network of 30-40 sampling plots in three forests: Verna, historically managed by Franciscans, Camaldoli, managed by Camaldolese monks, and Sasso Fratino, a remote forest which was sporadically managed in the last centuries and became a strict forest reserve in 1959.

The three forests are mixed with beech (*Fagus sylvatica* L.), other broadleaves and silver fir (*Abies alba* Mill.) a conifer that is spontaneous in this region but that, in the same time, it is locally strictly linked to the history of the monks that have applied for centuries different silver fir "monastic silviculture".

Even if all three forests have recently gone unmanaged or managed with a low intensity, current forest structure and dynamics were strongly influenced by the legacies of past human land-use. Current differences in structure and process reflect both the different management purposes and the different attitudes towards the forest of the Franciscan and the Camaldolese monks.

The recognition of these historical legacies is a major challenge in managing current and future biodiversity and natural heritage conservation.

S5-6

Management based on traditional local knowledge and conservation of *Abies alba* in Calabria (Southern Italy)

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Abies alba Mill. grows in the mountainous forests of Central and Southern Europe where it is an ecologically and economically important tree. The southern Apennine mountain range in Italy is the southernmost glacial refugium of *A. alba*. From here silver fir has re-expanded along the Apennines where it now grows on a smaller area compared to the one occupied by the species in the past. Today the southernmost range of silver fir is in fragmented nuclei in the mountains of the Calabria region, where it is often mixed with beech (*Fagus sylvatica* L.). Conservation of *A. alba* in this area is very important because here the species shows great differentiation from the rest of the *A. alba* populations.

The largest vegetation area of silver fir (approx. 3600 ha) is in the Serre Vibonesi mountains where the species grows in pure stands or, more often, in mixed stands both on public (35%) and private lands (65%). The management history of the last centuries has produced a variety of structures and species mixtures, ranging from pure even aged fir stands following clear felling and artificial regeneration, to stands with more complex structure and composition managed by traditional selection felling based on local traditional knowledge. Based on a review of preceding studies and on new field data, this work analyzes how different management approaches have impacted and are still impacting on fir presence in the area. Results outline management guidelines for the conservation of this species in mixed stands based on natural regeneration processes.

P-01

Phylogenomics and species delimitation in the Mediterranean firs

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Genomic data are an important source of evidence for delimiting species. Bayes factor species delimitation (BFD) allows testing non-nested species delimitation models in a flexible way. Previous phylogenetic studies in the Mediterranean firs, based on data from a few molecular markers, were inconclusive and they did not clarify interspecific relationships. We applied BSD using the software SNAPP and BEAST to investigate the speciation history of the Mediterranean firs. We used restriction site associated DNA sequencing (RAD-seq) to investigate the diversification processes of this group. Over 6000 filtered SNPs produced a well-supported phylogenetic tree and generally confirmed the monophyletic origin of all the Mediterranean firs, as well as their separation into the two previously recognized sections: sect. *Abies* and sect. *Piceaster*. The BFD analysis showed that species diversity in the Mediterranean *Abies* is currently overestimated, as *A. marocanna* and *A. tazaotana* seems to be the same taxon. The rest of the 10 recognized taxa appeared as independent species (*A. alba*, *A. nebrodensis*, *A. cilicica*, *A. cephalonica*, *A. equi-trojani*, *A. bornmuelleriana*, *A. nordmanniana*, *A. pinsapo* and *A. numidica*). This study shows the first species delimitation based on genome-wide SNP data and it reflects the most conservative estimate for the number of species within this group.

P-02

A complex evolutionary history shaped the distribution of *Abies alba* (Mill.) genetic variation along the Apennines

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Mediterranean refugial areas are generally underrepresented in large-scale genetic surveys on forest trees. In the case of silver fir (*Abies alba* Mill.), this has led to several hypotheses about the exact location of refugia and the trajectory of recolonization routes. Exploring the demographic history of silver fir rear edge populations by comparing different hypotheses developed from palaeobotanical and genetic data is particularly urgent considering their paramount evolutionary, ecological and conservation value due to peculiar genetic and eco-physiological features.

To this aim 16 Apennine populations, exhaustively covering the species' distribution along the Italian peninsula, and eight populations from the Alps and Eastern Europe were genotyped at 16 nuclear and three chloroplast microsatellite markers. The geographical distribution of genetic variation was explored by Bayesian clustering and multivariate methods. Based on inferred genetic structure, the demographic history of *A. alba* was assessed by Approximate Bayesian Computation analysis.

Two unexpected characteristics of silver fir genetic structure in the Apennines emerged from our data: a sharp genetic boundary in central Apennines and a tight genetic connection between southern Apennine and Eastern Europe gene pools. Two Apennine areas where genetic diversity is large and comparable with Eastern European populations have been identified as potential long-lasting refugia, strictly corresponding to refugial areas hypothesized in most recent palaeobotanical syntheses. In addition, evidence about central Apennines having acted as a small-scale, isolated refugium during the Last Glacial Maximum is provided.

Silver fir rear edge populations have experienced a complex demographic history embracing several Pleistocene ice cycles, which have determined unexpected characteristics of their genetic structure. Bringing out such peculiar characteristics, our study sheds light on processes involved in shaping the distribution of genetic diversity in refugial areas.

P-03

Range shift and introgression of three Japanese *Abies* species : insights from microsatellite, mtDNA and species distribution modelling

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Range shifts during the Pleistocene shaped the unique phylogeographical structures of numerous species. The Pleistocene range shifts gave currently allopatric species the opportunities to occur in sympatry, which would probably have caused ancient introgressions between related taxa. Here, we combine an extensive survey of the mitochondrial (mtDNA) and nuclear (17 microsatellites) genomes in 42 populations of the three Japanese *Abies* species (*A. firma*, *A. homolepis* and *A. veitchii*) with species distribution modelling (SDM). From the Bayesian clustering analysis showed that the three species were clearly separated except for the *A. homolepis* var. *umbellate* population which is considered a natural hybrid between *A. firma* and *A. homolepis*. On the other hand, mtDNA haplotypes of the four northern populations of *A. firma* were completely replaced by two major haplotypes of *A. homolepis* and *A. veichii*. The neighbor-net analysis and SDM suggests that the mtDNA capture through historical introgression among species were occurred in each geographic region. We hypothesize that climatic-induced range shifts during the Pleistocene/Holocene may have played an important role in the observed patterns of introgression of these species.

P-04

Nuclear genome size of *Abies sachalinensis* in Hokkaido Island, Japan

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Genome size is an essential parameter in cell biology, molecular genetics and genomics. Conifer has uniquely giant genome, and the nuclear DNA amount was assessed as approximately 15-65 pg/2C in Pinaceae. In genus *Abies*, interspecific variation of DNA amount was detected a 1.2-fold range between 30.2 pg/2C in *A. balsamea* and 36.1 pg/2C in *A. concolor*. Sakhalin fir (Todo fir, *A. sachalinensis*) is an ecologically and economically important conifer tree in Hokkaido island, northern Japan. Although comprehensive study of nulear DNA amount had been conducted in plants, little is known about genome size of *A. sachalinensis*. In this study, nuclear genome size of *A. sachalinensis* was estimated by flow cytometry. Sample trees were located in Sapporo Campus, Hokkaido University. Fresh leaf was used for the determinations. DNA amount was measured using 4', 6-diamidino-1-phenylindole (DAPI) stained flow cytometry (Partec PA; Partec GmbH, Munster, Germany). To quantify the DNA amount, nuclear from fresh leaf of *Picea abies* was referenced. To confirm the quantification, propidium iodide (PI) stained flow cytometry was conducted. Preliminary result showed the nuclear DNA amount was 28.30 pg/2C (DAPI). According to an article from Norway spruce genome project (15.56 pg /1C = 15.2 Gbp), nuclear genome size of *A. sachalinensis* was estimated 13.8 Gbp/1C. This value was the smallest in genus *Abies* previously reported, implying unique evolution of *A. sachalinensis*. We will present results of quantification from PI stained flow cytometry and geographical variation of DNA amount for *A. sachalinensis* in Hokkaido Island, Japan.

P-05

Molecular selection for low water availability and extreme temperatures in the Mediterranean *Abies* species: a SNP approach

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Adaptations to stressful environmental conditions are ones of the most important answers plant species can develop before new habitats. These adaptations should be genetically fixed so as not to be considered products of phenotypic plasticity. In order to detect these changes, ones of the most sensitive genetic markers are SNPs. In this study, we assessed this question in relation to drought and extreme temperatures with all the Mediterranean *Abies* species, i.e. *A. pinsapo* (3), *A. marocana-A. tazaotana* (4), *A. numidica* (1), *A. borisii-regis* (3), *A. bornmuelleriana* (3), *A. equi-trojani* (1), *A. nordmanniana* (2), *A. cephalonica* (3), *A. cilicica* (3), *A. alba* (4) and *A. nebrodensis* (1); number of populations per species within brackets. This assessment departs from previous phylogenetic and phylogeographic reconstructions of these populations, which contextualise the evolutionary direction of the detectable changes. SNPs, derived from a next-generation sequencing-based method (RAD-seq), are considered and their diversity compared to temperature and water availability related variables. Finally, results are discussed in the context of climate changes from the last interglacial period and for different climatic models.

P-06

Genetic structure of the relict Spanish fir *Abies pinsapo* Boiss.: an ABC approach

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The current genetic structure of the different species is the result of the interaction between different evolutionary processes and the historical events that occurred over time. The pinsapo (*Abies pinsapo* Boiss.) is an endangered fir belonging to the circumediterranean *Abies* group. Its current distribution range is restricted to three mountain ranges composed of several populations' nuclei, all located in SW Spain: Sierra de Grazalema, Sierra de las Nieves and Sierra Bermeja. The aim of this study is to characterize genetically the vast majority of the populations' nuclei that compose the whole area of distribution of the species and to investigate the most probable phylogeographical hypothesis explaining the current distribution. Nuclear (nSSR) and chloroplast (cpSSR) microsatellite markers were used to genotype the individuals. Different analyses (Mantel test, AMOVA, STRUCTURE and Bayesian analysis) were performed to investigate genetic structure and diversity, and phylogeographical hypotheses are proposed on this basis. Approximate Bayesian Computation (ABC) was used to compare the different plausible phylogeographical hypotheses and to estimate demographic and historical parameters that would allow the understanding of complex reality of the *A. pinsapo* history as well as the optimum management actions in conservation programs.

P-07

Evaluation of genetic structure and diversity within and among populations of an endemic species, *Abies veitchii* var. *shikokiana* in Shikoku, Japan

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Abies veitchii var. *shikokiana* is an endemic species which represents the south-westernmost part of *A. veitchii* populations and only found around the top of three mountains in Shikoku, Japan. Since there is an increasing threat of population decline of this species mainly due to ongoing climate changes, the effective techniques for the species' conservation, taking its genetic backgrounds into consideration, should be considered. In the present study, using genomic SSR markers, we evaluated genetic variation of the species together with *A. veitchii*, and also examined genetic diversity of next generation (seedlings) derived from seeds of mother trees within a population.

Genetic diversity statistics of three populations of *A. veitchii* var. *shikokiana* were lower than that of plus trees of *A. veitchii*, and out of the three, the western populations (Mts. Ishizuchi and Sasagamine) exhibited lower values than the eastern population (Mt. Tsurugi). South-westernmost populations should be more subject to genetic drift due to their longer isolation period. The STRUCTURE analysis detected clear genetic clustering among individual populations, indicating advance in population differentiation. In Mt. Ishizuchi population, genetic diversity of the seedlings was lower than that of adult trees, and also differed significantly among mother trees. Their low levels of genetic diversity would be attributed by a small number of contributing parent trees, and also affected the difference in surrounding population structure and the accompanying mating patterns.

P-08

Diameter structures in mixed species, near-natural and natural stands with *Abies alba*

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The main objective of this study is to assess the degree of tree diameter structural diversity of near-natural and natural stands with fir *Abies alba* Mill. I test specific hypotheses: (1) that near-natural and natural stands with fir are structurally heterogeneous; (2) that the gamma single and mixture distributions as well as the gamma shape mixture (GSM) model are very suitable for fitting the empirical tree diameter (DBH) distributions of these stands; and (3) that the Metropolis-Hastings MCMC method based on the investigated models is useful for a simulation study. This investigations were carried out in the forests growing in the Świętokrzyski National Park in Central Poland (50°50'−50°53' N, 21°01'−21°05' E).

Four groups of empirical DBH distributions were distinguished using hierarchical cluster analysis (HCA) and correspondence analysis (CA). The forests were structurally heterogeneous; investigated stands showed the slightly rotated sigmoid (SRS) type of empirical DBH distribution, the distinctly rotated sigmoid (DRS) shape, the bimodal M-shape (BMS) and the unimodal irregularly descending (UID) shape. Generally, the approximation accuracy of the GSM model and the gamma model consisting of two components was similar, but only the GSM model precisely separated older and younger tree generations. The least suitable function for DBH distribution modeling was the single gamma distribution. The Metropolis-Hastings MCMC method based on the investigated models has a good predictive performance.

P-09

Changes in the population structure of *Abies firma* in a temperate mixed forest located in Fukushima Prefecture, eastern Honshu, Japan

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Abies firma is a major coniferous species found only in temperate forests in Japan. This species is frequently in mixed forests along with broad-leaved species, but sporadically forms pure stands in the late succession stage. To understand the regeneration process of *A. firma*, we analyzed the changes in population structure over 10 years. In 2001, 2006, and 2011, all *A. firma* trees with a diameter at breast height (DBH) > 5 cm were censused in 0.25 ha and 0.44 ha plots established in the Abukuma Mountains, Fukushima Prefecture. In this stand, *A. firma* and evergreen broad-leaved species such as *Quercus salicina* dominate. In total 386 *A. firma* trees were found in these plots. Both the basal area and trunk number of the trees increased over the 10 years. The canopy layer of the forest is a mosaic of evergreen conifers, deciduous broad-leaved trees, and evergreen broad-leaved trees, and the forest floor photoenvironment within the plots is heterogeneous, being influenced by canopy tree type. Recruitment trees were found mostly under deciduous broad-leaved trees. The growth rate of *A. firma* trees varied considerably. For dying trees, the DBH was small (< 30 cm) and the growth rate was low. These trees were distributed under large *A. firma* trees. These results suggest that the growth rate and the abundance of regenerated *A. firma* were affected by light conditions.

P-10

Regeneration Niche of *Abies firma* in the Species-rich Temperate Mixed Forest: a Multi-scale Analysis Linking Geographical Distribution, Stands and Reciprocal Patches

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In the genus *Abies*, *A. firma* Sieb. et Zucc. (Japanese fir) is characterized by (1) distribution under temperate climates with little snow, and (2) coexistence with both climax evergreen and deciduous broad-leaved tree species in the vegetation zone of 'temperate ecotone.' In the present study, I examined (1) the diversity and dynamics of temperate mixed forests and (2) the regeneration traits of dominant *A. firma* in the northern border of its geographic distribution, i.e., the Pacific side of the southern Tohoku region, through a multi-scale analysis of regional-, stand- and patch/gap-scale domains.

Regional-scale mapping of *A. firma* illustrated the habitat preference and corridor along the Pacific, and stand-scale censuses in four old-growth temperate mixed forests along the geographic environment gradient showed variety in floristic composition and spatiotemporal mosaic structure. Through patch/gap-scale surveys regarding density, size structure, height growth, canopy architecture, seedling mortality, shade tolerance and cold resistance in Aoba-yama Hill forest, life-history traits and safe-site of *A. firma* were detected, compared with other main regeneration guilds such as late-successional evergreen *Quercus* species, and early- and late-successional deciduous broad-leaved tree species. Reciprocal succession could be a key concept not only for meta-population persistence of *A. firma* but also for wise management of species-rich temperate mixed forests.

P-11

Recruitment, Growth and Mortality of Sakhalin Fir (*Abies sachalinensis*) in Northern Japanese Mixedwood Stands Managed under Selection System

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Uneven-aged mixedwood forests of evergreen conifer and deciduous broadleaved species are widely distributed in Hokkaido, northern Japan. Among native trees, Sakhalin fir (*Abies sachalinensis* (F. Schmidt) Mast.) is one of the key species in the region. Selection system that maintains an uneven-aged stand structure by periodically removing individual trees has been employed to manage mixedwood stands in Hokkaido, and Sakhalin fir is of economic importance under the silvicultural system as it is a primary source of timber. Reliable application of selection system can be facilitated through better understanding of individual species' demography. In this study, we examined the stand-level demographic parameters (recruitment, growth and mortality) of Sakhalin fir in a cool-temperate mixedwood forest managed by selection system in central Hokkaido. Tree census data collected from permanent plots at the University of Tokyo Hokkaido Forest was used for the analysis. Single-tree selection cutting have been conducted at least 1–3 times over the past 40 years. All trees with diameter at breast height (DBH) greater than 5.0 cm have been measured in each plot at 5-year intervals, with 0.1-cm precision. Newly recruited trees that reached the minimal DBH, harvested trees, and trees died during the measurement intervals were recorded consecutively. We calculated the recruitment, growth and mortality rates of Sakhalin fir. This study also examined how stand and site conditions as well as selection harvesting affect the species' demography.

P-12

The influence of gap size on growth and development of silver fir regeneration in near-natural mixed stands in the Świętokrzyskie Mountains

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The size of a gap can strongly influence tree species regeneration composition, vegetation growth, nutrient cycling, microclimate and can considerable effect on a number of biological processes. The aim of this study was to understand the effects of gap creation and variations in different treefall gap size on the number and height structure of natural silver fir regeneration. Following hypothesis was tested: better conditions for fir growth as shade-tolerant species are in small gaps. The study was carried out in near-natural mixed stands dominated by beech (*Fagus sylvatica* L.) and fir (*Abies alba* Mill.) representing different development stages and phases in the Świętokrzyski National Park, Poland. All gaps over than 20 m^2 intersected by a transects line were sampled and each marked point was measured in. All saplings outside seedlings were counted in circular plots (5 m^2) evenly spaced along the long axis in the N-S and E-W gradients of each gap. Regeneration of fir was analyzed for 62 canopy gaps of various sizes. The gap size ranged from 21 to 397 m^2, with a median of 104 m^2. The fraction of land area in gaps was estimated at 4.5% of total stand area. The number of silver fir regeneration significantly depended on the gap size (p=0.01). The highest frequency of fir saplings (less than 0.10 m in height) was found in gaps of $\leq$ 100 m^2 and 100-250 m^2 ($p < 0.05$). The number of silver fir saplings was a significantly negative correlation with gap size. This study confirmed the hypothesis. The regeneration density of silver fir of all height classes under stand canopy was significantly greater ($p < 0.01$) than in gaps. This suggests that new regeneration under canopy form a persistent sapling bank waiting for creation a gap. It implies that sapling bank can be critical in the regeneration of forest. Species composition in gaps of all sizes and under stand canopy was relatively homogeneous. The presence of gaps did not increase the heterogeneity of forest structure by creating new microsites such as snags, stumps, and root-plates. The dominant tree species regenerated in gaps were fir (67%) and beech (26%). The results of this study demonstrate the utility of gap-based approach for better understanding ecosystem responses to tree cutting for modern forest management.

P-13

Fir and its ectomycorrhiza from local to global scale

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The genus *Abies* is with roughly 40 species a widely distributed genus throughout Europe, northern Africa, northern and central Asia, and North America. All species are ectomycorrhizal yet mainly *A. alba* was more intensively studied for ectomycorrhiza diversity. The current knowledge of silver fir symbionts is predominantly based on morphological and anatomical descriptions of ectomycorrhiza and fungal fruiting bodies. Few molecular investigations of the ectomycorrhizal symbionts appear in the literature. The aim of this study is to make a local diversity study of ectomycorrhiza on *A. alba* and put it in a context of the global ectomycorrhiza diversity of *Abies* spp. Based on a review of existing papers up to 50 different mycorrhizal taxa were identified from *Abies alba*. For other species of *Abies* the data on ectomycorrhiza is spare this we are preparing a global review of existing descriptions and an additional sampling to fill the gaps in geographic distribution of *Abies* spp ectomycorrhiza for the dominant *Abies* species with an aim to cover the issue at the global level.

P-14

Decaying and development of fruiting body in the stem of Sakhalin fir inoculated with *Fomitiporia hartigii*

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Abies sachalinensis (Sakhalin fir), an indigenous species in Hokkadio, northern Japan, is one of the major tree species for afforestation in Hokkaido. Decaying is a serious problem that causes economic loss because Sakhalin fir tends to be infected by wood-decaying fungi. *Fomitiporia hartigii* (synonym: *Phellinus hartigii*) is a white rot fungus that commonly infects Sakhalin fir. It causes sap rot with longitudinally elongated lesions on the stem. To elucidate the time lapse after the infection of the causal fungus in naturally affected trees, the fungus was inoculated to the live branch stubs on the fir. The lesions longitudinally appeared from the inoculation point 3 years after the inoculation in the earliest case. The average rates of annual extent and annual increase of volume were 11.4 $cm \cdot yr^{-1}$ and 76.0 $cm^3 \cdot yr^{-1}$, respectively, although they markedly varied with individual trees. The area of the lesion correlated with the decay volume. This correlation suggested that the decay volume affected by *F. hartigii* in the stems was estimated from the area of the lesion on the bark of the infected fir. Another inoculation experiment showed that fruiting bodies of *F. hartigii* were successfully developed in 10.7% of the total number of inoculation points within 13 years after the inoculation. Considering that natural infections are initiated through branch stubs or stem wounds by airborne basidiospores disseminated from fruiting bodies, it seems that much more time will be needed for the fruit body formation of *F. hartigii* after infection by basidiospores in an actual field condition than that in an experimental inoculation.

P-15

Effects of Snow Manipulation Treatments on Damage to *Abies sachalinensis* Seeds by Soil-born Fungi

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In a heavily snowy region of northern Japan, natural regeneration of conifers including *Abies sachalinensis* is seriously inhibited by soil-born fungi that infect to seeds under snow cover and cause snow blight diseases. The infection rate of these fungi is known to increase with the duration of snow cover, because the stable temperature of around 0 °C and the abundant moisture on the ground soil under snow are preferable to the fungi. We examined the effects of snow manipulation treatments on the infection and seed germination ability of *A. sachalinensis* seeds. We set up plots in mixed forests in Hokkaido and conducted three types of treatments: snow removal by shovel, snow-melt promotion using snow melting agent in order to reduce snow cover duration, and trench digging in order to induce soil freezing on the forest floor. Seed bags containing *A. sachalinensis* or *Picea jezoensis* seeds as a reference were set on the forest floor in each plot during snow season. For recovered seeds, infection of fungi and seed germination ability were examined. Trench digging reduced the infection rate of fungi in both *A. sachalinensis* and *P. jezoensis* seeds, and the effect was more pronounced in *P. jezoensis* than *A. sachalinensis*. Seed germination ability was completely lost in control plots, while it was maintained at 33-46% in *A. sachalinensis*, 42-53% in *P. jezoensis* seeds in the plots treated with trench digging. Results indicated that seeds could escape from fungal damage because soil freezing by digging trenches reduced fungal activity.

P-16

Monitoring the effect of ungulates on forest regeneration in Slovenia

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Ungulate browsing is an important factor that can affect tree establishment, growth and mortality and thus both structure and species composition of forests. Measuring and monitoring the effects of ungulates on forest regeneration is needed to ensure suitable ungulate management enabling sustainable regeneration of forest stands. Evaluation of ungulate browsing in Slovenia started in 1970s and in 1996 national browsing damage monitoring was introduced. From there on browsing damages are regularly checked by Slovenia Forest Service. In order to deliver statistically sound information about browsing pressure on forest regeneration at state and regional level, monitoring system was revised in 2009 and 2010 and re-measured in 2014. The revised monitoring system is based on stratified sampling where entire forest area is divided in to 35 inventory units (300 – 1000 km^2 each), taking into account habitat characteristics and transitional barriers of herbivorous ungulates, forest types and forest management approaches. In each inventory units 51 plots are randomly selected. Plots are rectangular in shape and with varied plot area. On each plot, seedlings and saplings are recorded for each tree species and classified in five height classes (<15 cm, 15-29 cm, 30-59 cm, 60-99 cm, 100-150 cm). The monitoring system is rational, simple enough and allowing verification of results. Its advantages and disadvantages will be discussed and applicability of results for coordinated wildlife and forest management will be presented.

P-17

Photosynthetic responses of Sakhalin fir seedlings exposed to elevated ozone: a preliminary assessment

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Sakhalin fir (*Abies sachalinensis*) is a representative tree species for timber production in Hokkaido. Most Sakhalin fir plantations are ready for harvesting and reforestation. We should evaluate effects of environmental change on these seedlings because it will take at least 40 years to a mature.

One of the most serious problems in Asia is a huge amount of air pollution which has been emitted by the Industrial development. Above all, the ground-level ozone (O_3) concentration is once again increasing in Japan. The O_3 absorbed via stomata causes the oxidation stress on the function of chloroplast. Nowadays, relatively high O_3 is detected in Hokkaido. Therefore to fulfill forest conservation, we should reveal effects of O_3 on the physiological responses and growth of trees native to Hokkaido .

Some researches have realized that O_3 decreases dry mass of Japanese fir (*Abies homolepis*). However, no research has been done on the effects of O_3 to Sakhalin fir. In this presentation, we show preliminary results of the Sakhalin fir seedling's responses to O_3. We will especially focus on the growth, allocation, photosynthesis and chlorophyll fluorescence response.

P-18

Biomass partitioning, photosynthesis and root starch of Japanese fir (*Abies firma*) saplings in response to light condition

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We studied changes in leaf photosynthetic traits, biomass partitioning and root starch contents on saplings of Japanese fir (*Abies firma*) growing under deciduous forest in Shikoku, Japan. We selected 10 to 16 saplings for the study. The relative light intensity (RLI) of the saplings varied from 90 to 0.5% in summer, though the values significantly increased during winter and early spring by shedding of deciduous canopy trees. Saplings under summer shade condition indicated lower photosynthetic rate at light saturation (P_{max}) and dark respiration rate (R_d), whereas saplings under strong light condition through year round showed higher P_{max}. Root starch contents showed higher value at spring (March and April), and then the values decreased significantly at summer (August and September) regardless of sapling light condition. High photosynthetic production during canopy defoliation period may cause high root starch storage of the saplings. Under shade condition, root starch may contribute to sapling survival during summer even without positive carbon gain by leaf photosynthesis. Higher biomass allocation to leaf component was observed at high light condition, whereas saplings at shade condition showed relatively high allocation to root biomass. Large leaf biomass with high photosynthetic ability at strong light condition may facilitate their growth rate. In contrast, large root biomass ratio of the saplings at shade condition may contribute to increase their stored starch. Those results suggest that Japanese fir saplings adapt to different light condition through changes on leaf photosynthetic ability, root starch content and biomass partitioning.

P-19

Effects of xylem embolism on winter survival of *Abies veitchii* shoots in an upper sub-alpine region of central Japan

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Evergreen conifers are typically dominant in cold habitats, such as sub-alpine and sub-arctic regions, because embolism caused by freeze-thaw events is minor relevance in conifers with small tracheid. However, despite these adaptations, the incidence of xylem embolism has been reported to be higher at sites that experience harsh winter conditions compared to sites in the alpine timberline that generally experience relatively milder conditions during winter and severe desiccation damage is frequently observed in late winter. We hypothesized that severe xylem embolism prevents water supply from the bark reservoir to the shoots tip when soil water uptake is prevented due to soil-water freezing. In the upper sub-alpine region (2,300 m above sea level) of Yatsugatake Mountains in central Japan, we compared the winter water relations of *Abies veithcii* shoot tips for normal trees at a wind-protected site and trees with a flagged crown at a wind-exposed site. In addition, we evaluated water movement from the bark reservoir to the shoots tip through the conducting systems of the branches and stems by the conducting dendrometer measurements. In winter, severe embolism occurred in the shoots of the wind-exposed trees, whereas the rate of percent loss of conductivity was only about 40% in the shoots of the wind-protected trees. At the protected site, water stored in older branches and stems was available to maintain the water content of the tip needles above lethal levels throughout the winter. Conversely, at the wind-exposed site, the limited water supply resulting from severe xylem embolism induced severe frost desiccation damage of needles in late winter. Our findings show that xylem embolism in winter may be a crucial for winter survival of the shoots tip of wind-exposed *A. veitchii* individuals.

P-20

Adaptation to freezing in evergreen leaf cells of fir (*Abies sachalinensis*)

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Freezing resistance is a primary determinant of the geographical distribution of trees. In cold regions, tree cells have developed freezing adaptations to prevent lethal intracellular freezing at winter freezing temperatures. However, there have been few cellular-level observations of the freezing response of evergreen leaves of trees. In this study, cryo-scanning electron microscopy (Cryo-SEM) was used to observe the freezing response of leaf cells of the evergreen fir tree (*Abies sachalinensis*). To elucidate leaf freezing adaptation at a cellular level, the freezing responses of winter leaf cells that have very high freezing resistance were compared to those of summer leaf cells that have poor freezing resistance. Cryo-SEM observation revealed accumulations of extracellular ice crystals in intercellular spaces within mesophylls and in transfusion tissues adjacent to phloem in summer and winter leaves that were frozen to -30ºC at a cooling rate of 5ºC/day. The frozen summer and winter leaf cells both exhibited extracellular freezing that resulted in dehydration of water from the cells induced by the formation of extracellular ice crystals. The degree of shrinkage of extracellularly frozen cells was less in winter leaves than in summer leaves. It is suggested that accumulations of compatible solutes in winter cells inhibit the close apposition of membranes under the freezing conditions that result in irreversible ultrastructural damage of the plasma membrane.

P-21

Evaluation of thermal conditions for the explanation of annual variation in the seed-cone bud production of *Abies sachalinensis*

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Seed-cone bud production, which is a fundamental process of reproduction, is influenced by thermal conditions at the early stage of shoot elongation in *Abies* species. Since the phenology of shoot elongation is also influenced by thermal conditions, I evaluated thermal conditions at two stages of seed-cone bud production by selecting generalized linear mixed models that included temperature sums during the periods after the day exceeding threshold temperature sums from January 1. Annual variation in seed-cone bud production was investigated for 10 canopy trees from 2000 to 2012 at Nakayama Pass in southwestern Hokkaido, Japan. Seed-cone bud indices were calculated with the number of seed-cone rachides, including aborted ones, on each 3- to 5-year-old branch axis and the number of the axes of the same age in each year. Temperature sums were calculated using climate data recorded near the study site by the Hokkaido Regional Development Bureau for maintaining a national highway. With respect to the period for calculating temperature sums, calendar dates were also adopted for some models. Among the fitted models, the AICs of models using temperature sums at two stages were smaller than those of models using calendar dates. In the best fitted model, the period for calculating the temperature sum almost corresponded to the early stage of shoot elongation. These findings suggest that the temperature sum during the early period of shoot elongation contributes to the development of seed-cone buds. Regarding an explanation of the annual variation in seed-cone bud production, it might be appropriate to evaluate the temperature sum for a period after the day exceeding the threshold temperature sum from January 1 rather than for a period determined only by calendar dates.

P-22

The vulnerability of silver fir populations to damage from late frosts

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Testing a population of forest trees can determine their adaptability, direction and range of movement, as well as to evaluate the plasticity of origins in a changing environment. The aim of the paper was to select a population of silver fir with the greatest potential for adaptation to the climatic conditions in south-eastern Poland. The evaluation of the test population was based on their vulnerability of apical and lateral shoots to damage effects due to late frosts. Observations of damage from late frosts were conducted in 2009 and 2014 on the series of four experimental surfaces, testing the progeny of select seed stands, in a randomized block design with four replications. Statistical analysis involved the general linear model for classifying variables: position, year, type of damage, the population and the interaction between them. The calculation is based on the GLM procedure (SAS 9.3 package). Significance was observed in the differences in the incidence of damage from late frosts between the tested populations (p=0.002) and fertile stands ($p < 0.001$). Adverse climatic conditions resulted in a significantly higher incidence of damage to shoot tips than in side shoots in most of the tested population. The results of this study provide the basis for dividing the tested population into two groups with low (EF, KRA1, NAR) and high (LES2, BAL2) sensitivity to negative temperatures during the growing season. The results of these study allow for improved selection of populations most adaptable to grow in the mountain climate.

P-23

Long-term dynamics of a wave-regenerated forest following large-scale typhoon disturbance

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Even under the current non-equilibrium view of ecosystems, the wave-regenerated *Abies* forest represents a rare example of a system being in a shifting-mosaic steady-state, where canopy disturbance is sufficiently frequent and small-scale to maintain the system in an equilibrium state at the landscape scale. However, a catastrophic super typhoon passed over a wave-regenerated forest in central Japan in 1959. Here, we assessed the long-term dynamics of the wave-regenerated forest and the effects of large-scale disturbance on it. Analysis of aerial photographs confirmed that the canopy was heavily disturbed by the typhoon. In 1954 (i.e. before the typhoon), the forest comprised stands of varying age based on a census along the transect. Older stands with high aboveground biomass and high canopies disappeared after the typhoon. Consequently, the post-typhoon forest mainly consisted of stands established around 1959. Thus, the typhoon caused a gradual change in age class distributions and in the aboveground biomass of the forest. The relative abundance of *A. mariesii* compared to *A. veitchii*, with the former being more shade tolerant, also varied considerably across census years, clearly indicating the influence of large-scale disturbance. Our results suggest that, in combination, frequent small-scale disturbance and infrequent large-scale disturbance produce a non-equilibrium state with respect to forest structure and species composition.

P-24

Seeds were the least contaminated by radiocesium in Japanese fir (*Abies firma*) in Fukushima, Japan

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The genetic and physiologic soundness of seeds is of paramount importance for all plants. A large amount of artificial radionuclides released from the TEPCO's Fukushima Daiichi Nuclear Power Plant deposited on forests, and it may negatively affect the seed soundness of trees in the forests. However the information on the contamination level of the radionuclides of tree seeds is quite limited due to a low chance to encounter them; the fructification of most trees occurs sporadically. Japanese fir (*Abies firma*), a predominant tree in natural secondary forests in northeast Fukushima also shows supra-annual occurrence of fructification. Consequently the contamination level of seeds of this species remains unknown. But fortunately we could encounter the fructification of the tree in November 2015. In this study, we investigated the concentration of radiocesium in seeds of Japanese fir and compared it with that in other strobile parts (wings and ovuliferous scale complexes) and needles. We performed the study in mixed deciduous and coniferous forests in Iitate, Fukushima. Needles and strobiles were sampled from 4 trees. Storobiles were separated into seeds, wings and ovuliferous scale complexes. The radiocesium concentration in the samples were determined by a low background Ge detector. The concentration of radiocesium in seeds was significantly lower than that in needles in most cases, whereas that in wings and ovuliferous scale complexes tended to be higher than that in needles. Results indicated that the contamination level of radiocesium in seeds was lower than other parts of trees. Seeds seemed to be the least vulnerable to radiocesium in a tree body.

P-25

Promising fir provenances for mitigation of climate change effects: a top-down approach in provenance testing at eco-zone level

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Provenance research provides many insights into the ecological amplitude of species and their respective ecotypes. Moreover, molecular markers allow to identify valuable fir populations showing high levels of genetic variation and diversity. But forest practitioners need urgently recommendations for using provenances suitable for mitigation of those dramatic climate change effects in forestry, what we face actually.

We designed a provenance test for the needs of the district Hartberg-Fürstenfeld in Styria /Austria, which is to be found at the eastern foot hills of the Alpine mountains building a transition zone to the basin of Graz. The region of Hartberg is characterized by an average temperature of 9.3 ^{o}C and an average precipitation of 725 mm per year. Two experimental sites were selected representing the different environmental conditions of the district: one at mount "Kulm" at an elevation of 852 m a.s.l. and a second experimental site in the basin at 356m a.s.l.

Alltogether 12 provenances from *Abies alba* were selected for testing: 4 local Austrian provenances, 4 provenances from the Carpathians (Romania), one from the Rhodope mountains (Bulgaria) and one from Calabria (Italy). In addition one provenance from *Abies bornmuelleriana* (Turkey) and one provenance from *Abies borisii-regis* (Bulgaria) were included. Plantlets were planted in spring 2016 using a randomized block design with two blocks at every experimental site. As the planting material was raised in different nurseries, we decided to analyse a subsample of 15 plantlets per provenance for metric traits as shoot length, RCD, root length, fresh weight of root and shoot respectively as well as dry weight. This paper includes results from summer mortality 2016. The findings are discussed in the light of the results from the IUFRO silver fir test series I and II in Europe.

P-26

Evaluating the home-site advantage in *Abies sachalinensis* in Hokkaido, based on the long-term provenance trials

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Abies sachalinensis is widely distributed in Hokkaido, the northernmost island of Japan. This species is an important component of sub-boreal forest ecosystems as the dominant climax species. It is suitable to elucidate genetic basis of local adaptation because this species is well known to show adaptive variation across their geographical range. To evaluate the magnitude of the home-site advantage across the geographical range and responsible environmental factors, we analyzed two long-term provenance trials which were both established in 1980 using over 50 families collected from various regions in Hokkaido: site-A (easternmost region) and site-B (western region).

The growth response and survival of planted families were clearly different between two sites, while the consistent negative effects of geographical distance between the seed source and the planting site on the performance were detected in both sites. This consequence of the home-site advantage was remarkable along a longitudinal gradient, rather than latitudinal gradient. Furthermore, the statistical modeling analysis indicated that the important environmental conditions driving this local adaptation were different between two sites: summer temperature and sunshine-duration in winter in site-A, sunshine-duration in April-June and October-December in site-B.

P-27

Year-to-year variation in paternal and maternal reproductive successes of Momi fir trees in Abukuma Mountains, eastern Japan

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The understanding of how mast seeding of tree species affects their genetic variation will ensure the sustainable management of forest genetic resources. Momi fir (*Abies firma*) is one of the typical coniferous trees found in cool to warm temperate regions of Japan. In this study, the patterns of gene dispersal of the species via pollen and seeds were compared among different reproduction events.

A total of 650 Momi-fir seeds were collected in three seeding years (2002, 2005 and 2010), using seven seed traps placed within a long-term monitoring plot (1.13 ha) in Abukuma Mountains, eastern Japan. Their embryos and megagametophytes were separately analyzed with 12 microsatellite markers. Parentage analysis was conducted by comparing their multilocus genotypes with those of 327 adult trees within the monitoring plot.

Although the seed rain density markedly differed among years (125.2 grains/m^2 in 2005 ~ 652.9 grains/m^2 in 2010), there was no definite annual variation in the proportion of paternal and maternal gene flow from outside the plot. Similar level of genetic diversity was also detected for the seeds sampled in three years. On the other hand, different adult trees contributed to the seeds in different years, and the proportions of adult trees that contributed as paternal or maternal parents in more than one year were only 42.4 % and 60.3 %, respectively. These relatively low values may indicate that reproductive success of each individual is not constant across the reproduction events, resulting in the year-to-year variation in genetic composition of the seeds.

P-28

Seed production and genetic improvement of *Abies sachalinensis* for plantation forestry in Hokkaido, Japan.

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Abies sachalinesis is one of the most important commercial tree species in Hokkaido. The plantation forests of this species occupy 771,000ha, more than a half of all the plantation in Hokkaido. Breeding program of the species started in 1950s and we have selected 782 plus trees, established 48 progeny test sites (208 ha in total) and 13 seed orchards (132 ha in total) from three breeding areas (south-west, center-north, and east) in the program. Seed production from the seed orchards started from 1980s, and now the orchards provide almost all seeds of *A. sachalinesis* for forestry in 2009-2013.

Genetic variation in cold hardiness is well recognized in *A. sachalinensis* by progeny tests and freezing tests (Hatakeyama 1981, Eiga 1985). Progenies from the western Hokkaido, the area had a heavy snow fall, had a resistance for snow damages. In contrast, progenies from the eastern Hokkaido had a resistance for freezing. They suggested the genetic variation among the provenances were resulted from the gradients of winter climate in Hokkaido, and their studies supported our breeding areas were appropriate.

We selected superior genotypes for growth rate and wood quality among plus trees by the results from progeny tests (so-called 1.5 generation) and the second-generation selection is just nearly completed. Our breeding program will increase the forest production and contribute the sustainable forest management in Hokkaido.

P-29

Advantages of using Todo fir snags for deadwood management in mixed *Abies* plantation–*Larix* plantation landscapes in Hokkaido, Japan

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Deadwoods provide essential habitats for many species. However, strategy for deadwood management in plantation forests has not been developed sufficiently because the effects of retained snags on biodiversity in plantation forests and on epidemics of bark beetles, one of main threats in deadwood management in conifer plantation forests, have not been fully-evaluated. We studied saproxylic beetle assemblages in 99 logs from 33 snags in Todo fir plantation forests and surveyed the literatures on longhorn beetles associated with Todo firs. We found that Todo-fir snags can provide habitats for at least 100 species of saproxylic beetles, and confirmed that *Polygraphus proximus* is the major bark beetle associated with fresh Todo fir snags in Hokkaido. We created snags by girdling planted Todo firs in four plantation stands (maximum number: 512 snags in ca. 4 ha) but we did not observed infestation of living trees surrounding the girdled trees. In addition, only a few occasions of Todo fir mortality by the infestation with *P. proximus* have been reported in storm-damaged plantation forests in Hokkaido. Therefore, we consider *P. proximus* may not be an aggressive pest such as European spruce bark beetle. We also found that *Zeteotomus maximus* was associated not only with fresh snags of Todo fir but also decayed snags. *Zeteotomus maximus* has been reported as a predator of bark beetles. In Hokkaido, Todo fir plantations and larch plantations are mixed in plantation dominated landscapes. Larch bark beetle *Ips subelongatus* is considered more aggressive than *P. proximus*. Todo fir snags may play an important role for providing sources of the biological control agent in the mixed landscapes.

P-30

From sacred to profane: the millenary silviculture of *Abies alba* from the Camaldolese monastic archives in Italy

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Monastic communities had a significant role in the socio-economic development during the upper Middle Age in Europe, especially in rural and in mountain areas. Some of them like the Camaldolese Benedictines privileged the hermit life and developed special skills in agriculture and forestry, and in particular had a strong commitment to Silver fir (*Abies alba* Mill.). In the XVI century they printed a collection of older monastic principles and forest management rules (dating back to XIII century), known as the Camaldolese forest code that allowed them to rule the conservation of *Abies alba* and to promote a sustainable forest management system that lasted for more than eight centuries. Silver fir is considered a symbolic species for the Camaldolese sylviculture, due to its remarkable tree height that "*enables to approach the sky and the extreme truth*". With this research we were able to scan and analyse several thousands of pages of original archive documents between XII and XIX centuries and to reconstruct their advanced forest management system. *Abies alba* was also economically crucial for the monastic communities due to its large use in civil architecture (Florence) and naval carpentry (Maritime Republic of Pisa and Genova) during the Renaissance era. The Camaldolese forestry system was complex, hierarchical, well organized and monks had direct managerial roles. The timber felling, extraction and transport operations (by animal skidding and river floating) were carefully planned. Timber selling and donations were minutely recorded in special ledgers that allowed today to estimate the number, the volume, the assortment types and to trace the sawing techniques and the destinations of silver logs and boards. These invaluable documents indirectly provide also ecological information about landscape and forest species composition changes, shedding some light on the role of *Abies alba* in the last millennium in central Italy.

P-31

Abies sachalinensis planted forests are important habitats for understory plants

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The montane region of Hokkaido, northern Japan, was once dominated by mixed broadleaf and conifer forests, but human disturbance eliminated conifers since the 19th century. During the second half of the 20th century, *Abies sachalinensis*, a native conifer species, was planted after mass clear-cutting. We investigated understory plants in the resulting *A. sachalinensis* stands and in neighboring natural broadleaf stands to identify the significance of planted conifer forests as habitats of understory plants.

We established 166 plots (20 × 20 m) in planted *A. sachalinensis* stands aged 47-61 years and 12 plots in broadleaf stands at the REFRESH (Retention Experiment for plantation FoREstry in Sorachi, Hokkaido) site. We measured DBH for all trees ≥ 1 cm in DBH, and placed a 5 × 5-quadrat at the center of each plot. Species of vascular plants were identified for each 1 × 1-m section of each quadrat, and species compositions were classified using NMDS (Non-metric Multidimensional Scaling).

We identified 231 plant species, and found that species composition differed between planted conifer stands and natural broadleaf stands. The understories of natural broadleaf stands were commonly dominated by dense dwarf bamboo *Sasa* spp., and species richness was low. In contrast, understory plants in planted conifer stands varied with the density of broadleaf trees established in conifer stands, stand age, and time since thinning. *Sasa* spp. are key components of understory plant communities, and closed canopies of *A. sachalinensis* eliminate *Sasa*. Our results suggest that old *A. sachalinensis* stands provide habitat for many native plant species.

P-32

Acclimation capacity of *Abies sachalinensis* seedlings to different light conditions after selection cutting.

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Abies sachalinensis (fir) is known to be shade tolerant and hence its seedlings can survive under shady understory conditions. When overstory trees are removed by selection cutting, fir seedlings in understory must acclimate to strong light conditions. We examined the morphological and functional process of acclimation capacity of fir seedlings in the understory of different sunny conditions for two years. We compared physiological parameters of fir seedlings grown under 3 different light conditions; sunny, shady and canopy gap (hereafter; gap) condition. This experiment was conducted at Uryu experimental forest, and selection cutting of overstory trees was made in February 2002 when the snow was about 1.5 m deep. The selection cutting rate was 26 % calculated at basal area. In this research we found that needles of the seedlings had different palisade mesophyll: i.e. needles under the sunny condition showed two layers of palisade mesophyll so as to defend against strong light, whereas the needles under shady condition showed only one layer. The needles of seedlings under gap were equipped with two layers in June 2002; therefore the structure of mesophyll may acclimate in a short period. The photosynthetic rate at light saturation (P_{sat}) resulted approximately the same in needles under sunny and gap in August 2002. However, seedlings under gap decreased their P_{sat} toward August in 2002, and xylem water potential (XWP) decreased, following the same pattern as P_{sat}. After one year, P_{sat} of seedlings under gap conditions did not decrease and neither did XWP in August, 2003. We conclude that fir seedlings acclimates needle structure during the four months after changes in light condition; however, morphological acclimation to light via water relations may take another year.

P-33

Genetic characterization of important regional silver fir populations in the Czech Republic

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Czech Republic, compared with other states, has available only few genetic information about population of tree species. This is also case of silver fir autochthonous populations. Presented work summarizes the basic genetic characteristics of 8 silver fir populations in the Czech Republic obtained by DNA analysis. For verification polymorphism of selected silver fir populations, method of using nuclear microsatellites was chosen.

Furthermore, it provides mapped overview which contains declared genetic conservation units with significant silver fir populations. Another map shows locations with more significant and less substantial occurrence of silver fir in protected areas. The genetic characterization of all analyzed populations was recorded at higher diversity of values. Differentiations between populations indicate their significant structuring. The shares of heterozygotes observed in populations ranged from 65-72%. Significant differences between populations were reflected in the frequency representation of specific alleles. The genetic distance of the monitored populations roughly corresponds to their geographic distance.

Key words: *Abies alba*, population, genetic diversity, DNA analyse, Czech Republic

P-34

Evaluation of quantitative and qualitative characteristics of various species of genera *Abies* in the Czech Republic

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In relation to the international EU project COST Action FP1202 "Strengthening conservation: a key issue for adaptation of marginal/peripheral populations of forest trees to climate change in Europe (MaP-FGR)" the main objectives of the project COST CZ LD14116 „The Czech Republic participation in the implementation of essential measures aimed at verifying the adaptability of threatened forest tree species in connection with ongoing environmental changes in Europe through the use of results gained from selected field trials with *Abies* species tested under various environmental and site conditions“ having been solved by the Forestry and Game Management Research Institute (FGMRI), Jiloviste–Strnady, Czech Republic from IV. 2014 to X. 2016 are focused to the acquisition of new knowledge of genetically conditioned variability of ecologically and economically important of characteristics of the species of genus *Abies*. The project is also focused on the verification of the use of these species in the Czech Republic forest management at the time of ongoing environmental change. In the context of this research project, the results will be obtained from evaluation of three long-term research plots with progenies of selected *Abies* genus species. These research plots were established by FGMRI in earlier times in the Czech Republic on sites with different environmental and habitat conditions. In the presented poster, there are partial results of evaluation of one from these three research plots, where are tested provenances of *Abies alba*, *A. grandis* and *A. procera*.

Key words: *Abies alba*, *Abies grandis*, *Abies procera*, provenance research, environmental changes, Czech Republic