



# Forestry training

## WITH I+ MARTELOSCOPES



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### Recommended citation

Derks, J., Schuck, A., O’Brien, L. (2022). Forestry training with marteloscopes. Integrate Network Report. European Forest Institute.

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The project FoReSite (‘Managing Forests for Resilience and Biodiversity – Bridging Policy, Practice, Science and Education’) is funded by the German Federal Ministry of Food and Agriculture (BMEL). It ran from 05/2020 to 07/2022 and strongly supported the activities of the Integrate Network, which promotes the integration of nature conservation into sustainable forest management at the policy, practice and research levels.

The illustrations produced for this report were financially supported by the ‘Swiss Federal Office for the Environment (FOEN)’.

Disclaimer: The present report is one output of the FoReSite project (‘Managing Forests for Resilience and Biodiversity – Bridging Policy, Practice, Science and Education’) supported by the German Federal Ministry of Food and Agriculture (BMEL). The views expressed in this publication are those of the authors and do not necessarily represent those of the European Forest Institute.

<https://integratenetwork.org/>

<http://iplus.efi.int/>

*This document aims to provide a basis for those who wish to get started using I+ marteloscopes as a part of their teaching. Marteloscopes are training sites where selective forest management can be practiced through the use of a simple software tool.*

*This handbook briefly outlines the role forests (can) play in education, before moving on to the reasons why forests management matters. Next, it touches on the layout of the Integrate Network Marteloscopes and the balance between wood production and biodiversity, and it introduces the I+ Trainer software. Finally, the documents includes some templates and suggestions for organising schooling and training for a variety of target audiences.*

*We regard this handbook as a living document - members of the Integrate Network are always welcome to contact EFI with suggestions or insights to improve the educational use of marteloscopes in the future.*



Photo: Andreas Schuck

## 1. Integrating wood production and biodiversity



1. A visit in a marteloscope (photo: Jakob Derks).

### 2.1. Continuous-cover forestry

There are essentially two methods of forest management, each of them known by a variety of terms. The first one is circular: trees are planted, they grow, when they are large enough they are harvested, and afterwards the forest is replanted. This is known as even-aged forestry with clear-cuts. The second style is continuous cover forestry, which – as the name indicates – is continuous. Selected trees are harvested on a regular basis, but the forest as a whole stays intact. Marteloscopes are typically found in forests with continuous cover forestry.



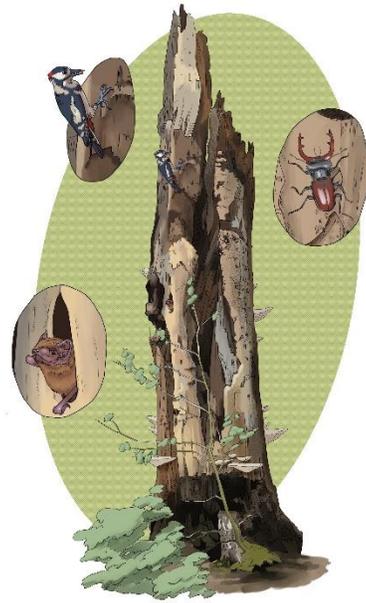
2. Even-aged forest management with clear-cuts and replanting.



3. Continuous cover forestry with selective thinnings and natural regeneration.

## 2.2. Tree microhabitats?

Large quantities of deadwood and a high density of old microhabitat-bearing trees are characteristic elements of natural forests, in particular in old-growth phases. These phases are often absent or rare in managed forests. close-to-nature management. In selective harvests and thinnings, 'defective' trees displaying or potentially developing old-growth habitat structures are often removed, to create space for other trees, to produce firewood or simply to keep the forest "clean". Yet, an important share of forest biodiversity is strictly or primarily dependent on such elements for their survival, especially saproxylic species, which are species that depend on deadwood. Most species dependent of old-growth phases and corresponding habitat structures have become rare. Conservation of biodiversity in commercial forest stands is thus linked to retaining such microhabitat structures.



4. *Deadwood brings life into the forest.*

Tree microhabitats (TreMs) are an essential part of any marteloscope. The catalogue of tree microhabitats was developed by a group of top-level experts to serve as a handy field guide that people can easily use in the field. The vast array of existing TreMs are subdivided into a few concise categories including saproxylic (cavities, injuries and wounds, bark, deadwood) and epixylic (deformations, epiphytes, nests) structures that can serve as shelter or home for different flora and fauna.

The catalogue is available as a pdf document but also as an app in the Google Play Store, under the name 'Catalogue of tree microhabitats'. It offers the same information as the printed catalogue, but in a form that is useful on a smartphone. On top of the information that is presented in the pdf version of the catalogue, the app also includes lists of species related to each of the TreMs.

The TreMs form the basis of the ecological assessment of the marteloscopes sites in the I+ Software, where they are linked to the ecological valuation of each tree within a given marteloscope. However, the field guide can also be used on its own as a useful support for determining valuable microhabitats during forest management.

### 2.3. Marteloscopes

Marteloscopes are usually one hectare large, rectangular forest sites where all trees are numbered, mapped and recorded. In combination with a software tool, they are used for silvicultural training. The concept of marteloscopes was originally developed in France. The term is derived from the French word for tree-selection (*'martelage'*) and the Greek term *'skopein'* (look), meaning literally "having a closer look" at a tree-selection. The concept was first applied in private forests but its potential for field-based training and education for forestry professionals and students was already recognised in the 1990s.



6. Schematic overview of a marteloscope.

In the Integrate+ marteloscope network, information is collected on (1) tree species, (2) tree status as dead/alive, (3) forest mensuration data (DBH, tree height and crown base height), (4) timber quality (estimated) and (5) tree-related microhabitats using the tree-microhabitat catalogue field guide. The collected information is then linked to a software application that can be used on-site to guide management decisions and to spur constructive discussions.

The [I+ Software](#) that runs on mobile devices can display tree-selection results directly in the field. This means participants can immediately visualise the outcomes of their silvicultural decisions and related ecological and economic consequences. In combination with the I+ Software, marteloscopes thus allow forest practitioners, decision makers, scientists and other interested groups to objectively discuss different management strategies and their consequences directly on site. Marteloscopes are commonly used as training sites for professionals including foresters, nature conservationists or researchers. But as marteloscopes highlight different issues on a manageable scale, they are also a good setting to get acquainted with the various aspects of forestry.

## 2.4. The I+ Software

The I+ Software is a tool consisting of three packages. The most important one for the on-site user is the I+ Trainer, which allows you to perform virtual thinnings and assess the ecological and economical effects of the operation.

The I+ Software is used when running exercises on the marteloscope sites. There is a tutorial available where an explanation of how to use the programme is explained step by step.

What can the I+ Trainer do?

- ✓ Compute and display wood volume and quality
- ✓ Compute and display biodiversity value based on tree microhabitats

The I+ Trainer does not:

- X Model future increment
- X Model potential future tree microhabitats

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### Want to learn more about...

How to set up a marteloscope?

- [http://iplus.efi.int/uploads/Marteloscope\\_Guidelines\\_Setup.pdf](http://iplus.efi.int/uploads/Marteloscope_Guidelines_Setup.pdf)

How to use the I+ Manager?

- [http://iplus.efi.int/uploads/20200319\\_UserManual\\_I%2BManager.pdf](http://iplus.efi.int/uploads/20200319_UserManual_I%2BManager.pdf)

How to use the I+ Trainer?

- [http://iplus.efi.int/uploads/I%2BTrainer\\_Tutorial.pdf](http://iplus.efi.int/uploads/I%2BTrainer_Tutorial.pdf)

Tree microhabitats?

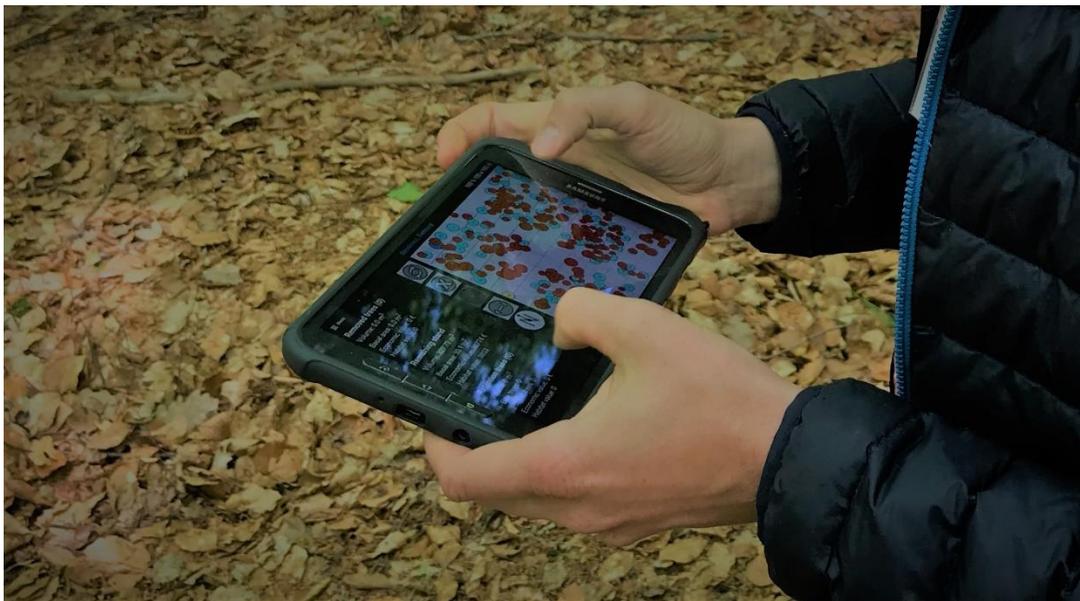
- [http://iplus.efi.int/uploads/Tree%20Microhabitat%20Catalogues/Catalogue\\_Tree\\_Microhabitats\\_EN.pdf](http://iplus.efi.int/uploads/Tree%20Microhabitat%20Catalogues/Catalogue_Tree_Microhabitats_EN.pdf)
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## 3. Organising marteloscope trainings

### 3.1. Who can benefit from marteloscope trainings?

Marteloscopes are first and foremost training sites, conceived to allow for on-site, fact-based discussions on the trade-offs which are inherent to any forest management decision. They have been used to train forestry students and professionals for many years. Due to their limited and clearly defined area, marteloscopes are equally suited for educational activities with school classes.

Each target group has its specificities in terms of didactic goals and methods. The table below gives an overview of possible exercise aims for different target groups.



7. Using the I+ Trainer on a tablet.

Overview of possible exercise aims for different target groups.

School	Primary school	<p><i>Aim: discover the forest</i></p> <ul style="list-style-type: none"> <li>• Find a mushroom, a woodpecker hole, a broken branch...</li> <li>• Look for the biggest tree in the forest</li> </ul>
	Secondary school	<p><i>Aim: introduction to forestry, linked with school classes</i></p> <ul style="list-style-type: none"> <li>• Connection to geometry classes (calculate volume of a tree...)</li> <li>• Connection to biology classes (photosynthesis and tree growth...)</li> <li>• Connection to geography classes (wood supply...)</li> </ul>
	Life sciences Bachelor's	<p><i>Aim: create awareness of the use of forest management</i></p> <ul style="list-style-type: none"> <li>• Determine tree species</li> <li>• Spot different microhabitat types</li> <li>• Look for traces of human interventions</li> </ul>
	Forestry Bachelor's	<p><i>Aim: get acquainted with the principles of thinning</i></p> <ul style="list-style-type: none"> <li>• Determine tree species</li> <li>• Spot different microhabitat types</li> <li>• Simulated thinning exercise in one quadrant</li> </ul>
	Life sciences Master's	<p><i>Aim: understand trade-offs between nature, economy and recreation</i></p> <ul style="list-style-type: none"> <li>• Thinning exercise in one quadrant</li> <li>• Microhabitat inventory (for a new marteloscope)</li> </ul>
	Forestry Master's	<p><i>Aim: understand trade-offs between nature, economy and recreation</i></p> <ul style="list-style-type: none"> <li>• Simulated thinning exercise on the whole site</li> <li>• Tree inventory (for a new marteloscope)</li> </ul>
Recreation	Recreationist	<p><i>Aim: create awareness of the use of forest management</i></p> <ul style="list-style-type: none"> <li>• Select some trees with valuable stems</li> <li>• Select some trees with high biodiversity values</li> <li>• Look for traces of human interventions</li> </ul>
Practice	Forestry professional	<p><i>Aim: understand trade-offs between nature, economy and recreation</i></p> <ul style="list-style-type: none"> <li>• Simulated thinning exercise on the whole site</li> </ul>
	Nature professional	<p><i>Aim: understand trade-offs between nature, economy and recreation</i></p> <ul style="list-style-type: none"> <li>• Thinning exercise on the whole site</li> </ul>
Research	Researcher	<p><i>Aim: create awareness of forestry work on the ground</i></p> <ul style="list-style-type: none"> <li>• Select some trees with valuable stems</li> <li>• Select some trees with high biodiversity values</li> <li>• Simulated thinning exercise on the whole site</li> </ul>
Policy	Policy maker	<p><i>Aim: create awareness of forestry work on the ground</i></p> <ul style="list-style-type: none"> <li>• Select some trees with valuable stems</li> <li>• Select some trees with high biodiversity value</li> <li>• Simulated thinning exercise in one quadrant</li> </ul>

### 3.2. Where to organise a training?

If you want to organise a training in a marteloscope, get in touch with a local marteloscope manager. This person is in charge of maintaining the site and organising events. You can find a list of all the marteloscopes and their managers here: <http://iplus.efi.int/marteloscopes-data.html>

The marteloscope managers can provide you with the password you need to access the I+ Software.

### 3.3. How to organise a training?

#### General recommendations

It is important to get acquainted with a specific marteloscope before going there with a group for a training exercise. For every I+ marteloscope there is a fact sheet with some basic but vital information including altitude, climate, soil characteristics, etc.

The list below provides a suggested and non-exhaustive list of items that could be useful when organising a marteloscope training. Of course, everything depends on the local circumstances and the target audience.

#### Preparation

- ✓ Fact sheets
- ✓ Poster of the stand
- ✓ PowerPoint presentation

#### Catering

- ✓ Shelter (hut, tent,...)
- ✓ Food
- ✓ Water
- ✓ Coffee

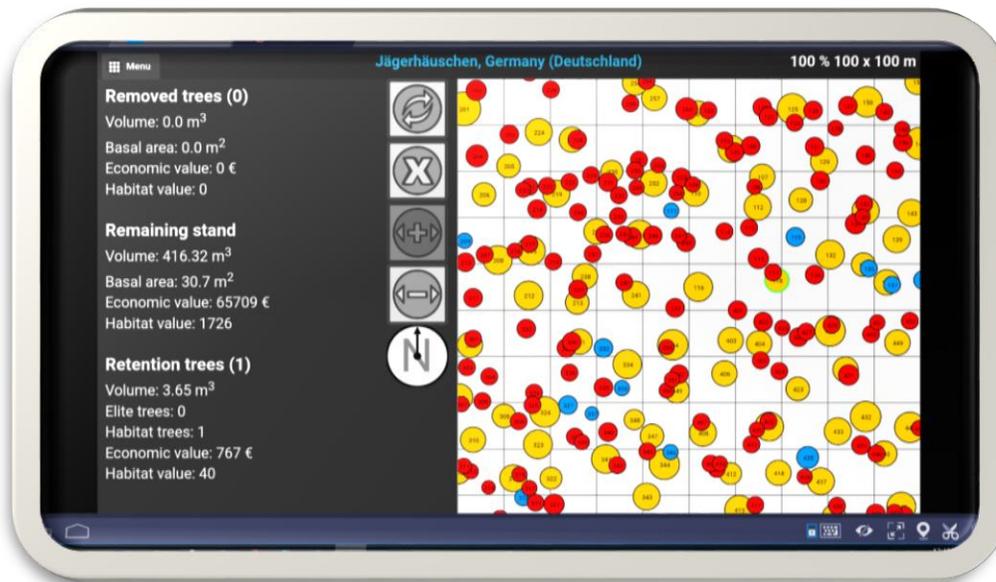
#### Technical equipment

- ✓ Tablets
- ✓ Binoculars
- ✓ Measuring tape

## 4. Training handouts

There are countless approaches that can be followed when organizing a practical training. Some existing guidelines can be found under <http://iplus.efi.int/documentation.html>.

It always makes sense to assess the current situation of the forest stand and to clearly plan which future evolutions should be promoted. This can be briefly outlined on a one-page template (see below). Chapter 5 then lists a few model exercises to be seen as inspiration for tailoring your own specific training events.



9. Screenshot of the I+ Trainer software running on mobile devices.

### Time plan

a. Introduction	30'
b. Analysing the stand	45'
c. Formulating management targets	15'
d. Marking the (virtual) thinning	90'
e. Discussing the results	30'
f. Present findings to the other groups	30'

## Before the simulated thinning

Briefly describe the stand in terms of ages, structure, and species composition.

.....

.....

.....

.....

Briefly describe the main biodiversity values of the stand.

.....

.....

.....

.....

What are the main management goals in this stand in the short, middle and long term?

.....

.....

.....

Which factors/circumstances could be beneficial for the desired development?

.....

.....

Which factors/circumstances could pose a threat to the desired development?

.....

.....

Summarise your goals in this table and use it as the guideline for your thinning.

	Status before thinning	Desired status after thinning
Species 1	...%	...%
Species 2		
Species 3		
Structure		
Basal area/light		

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Microhabitats

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Harvesting  
volume

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Other aspects

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## Virtual thinning

Please mark the thinning which according to you is needed during the next intervention.

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### Management targets:

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Trees species

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1.

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2.

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3.

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Thinning needs

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Practical aspects

(accessibility, skidding,  
forwarding, log storage,...)

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Environmental challenges

(soil, water, wind, fire,...)

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Increasing resilience

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## 5. Model exercises

This document describes a set of standard exercises that can be applied in Marteloscope training events. The exercises differ in their objectives and should be adapted according to the level of knowledge of the participants.

The exercise descriptions are deliberately kept quite general, as the exercises should be formulated and adapted according to the management objectives, site conditions, and local challenges (nature conservation, recreation, protection forest, etc.). Therefore, these exercise suggestions should be seen as a 'starting point', providing ideas for site-specific exercises.

The numerical values, which are presented in the exercise templates, should be regarded as exemplary values. The values should be adapted to the local conditions and exercise goals by the training personnel. The exercise templates also partially overlap in their specifications but have different objectives. The set objectives should be the focus in both the exercise introduction and the discussions. The below listed examples of exercise types are not exhaustive but are thought to support exercise managers in their work planning.

An exercise may focus on one individual aspect or a combination of several topics:

- Silviculture e.g., thinning regimes (examples: thinning from above/below, stand conversion, thinning with aim of favouring/conserving target tree species...), stand regeneration, stand stability....
- Economy e.g., maximum economic return, high quality timber removal/accumulation, elite tree selection....
- Nature conservation e.g., habitat/future habitat tree selection, deadwood accumulation....
- Specific training targets e. g. wood volume and basal area estimations, identifying trees/tree traits (identification and description of tree microhabitats), work safety, forest recreation, forest roads....

<b>Exercise type: silviculture (e.g., standard thinning)</b>		
<p>The goal of this exercise is to perform a low-intensity but high-value thinning, focusing on high-quality timber. The quality assortments and financial targets will have to be adapted to local conditions (trees species, wood buyers, wood processing industry).</p>		
<b>Beginner</b>	<b>Intermediate</b>	<b>Expert</b>
<p>Remove a predefined amount of high-quality timber (a few stems only) in m<sup>3</sup> (e.g., 30-40 m<sup>3</sup>) yielding a minimum revenue of 2000-3000 €.</p>	<p>Remove a predefined amount of high-quality timber (a few stems only) in m<sup>3</sup> (e.g., 40 m<sup>3</sup>) yielding a minimum revenue of 3000 €. Give attention to enhancing natural regeneration of target species.</p>	<p>Remove a predefined amount of high-quality timber (a few stems only) in m<sup>3</sup> (e.g. 40 m<sup>3</sup>) yielding a minimum revenue of 3000 €. Give attention to enhancing natural regeneration of target species. The exercise may also add additional tasks: (1) to take into consideration quality assortments with view on main clients (timber buyers, local wood processing industry), (2) to keep harvesting costs at a minimum or (3) to ensure not to compromise nature conservation targets / restrictions.</p>

<b>Exercise type: Thinning</b>		
<p>This basic exercise can be carried out in most types of forests (even-aged and uneven-aged, mixed or monocultures). The exercise can be set as a high or low thinning.</p>		
<b>Beginner</b>	<b>Intermediate</b>	<b>Expert</b>
<p>Remove 10 trees (can be combined with a broad removal target e.g. 50 to 100 m<sup>3</sup>) while preserving valuable habitat trees (aim: identification of tree microhabitats).</p>	<p>Remove 50 to 80 m<sup>3</sup> of trees while preserving the most valuable habitats trees.</p>	<p>Remove 60 to 70 m<sup>3</sup> of trees while taking into consideration natural regeneration; preserving the most valuable habitat trees.</p>

<b>Exercise type: Forest conversion</b>		
<p>The task of this exercise is to develop a more structured, uneven aged forest from an even-aged stand. Some important aspects to consider in the course of the exercise are stand stability, regeneration, and tree species composition.</p>		
<b>Beginner</b>	<b>Intermediate</b>	<b>Expert</b>
<p>Remove no more than a predefined value (in N, m<sup>2</sup>, m<sup>3</sup>), or percentage (%) of trees, basal area or volume ensuring that stand stability is not compromised.</p>	<p>Remove no more than a predefined value (in N, m<sup>2</sup>, m<sup>3</sup>), or percentage (%) of trees, basal area or volume ensuring that stand stability is not compromised. Give further attention to enhancing the natural regeneration of target species.</p>	<p>Remove no more than a predefined value (in N, m<sup>2</sup>, m<sup>3</sup>), or percentage (%) of trees, basal area or volume ensuring that stand stability is not compromised. Give further attention to enhancing natural regeneration of target species and enhance tree species diversity. Ensure the retention a sufficient number of habitat trees and / or habitat tree candidates.</p>

<b>Exercise type: Tree microhabitats</b>		
<p>The aim of this exercise is to extract a given volume of wood (m<sup>3</sup>) by removing a low number of high quality trees. Ecological objectives may require adaptation depending on local conditions. Future habitat tree candidates are not listed in the I+ Software and must therefore be selected based on the expertise of the participants and then jointly discussed.</p>		
<b>Beginner</b>	<b>Intermediate</b>	<b>Expert</b>
<p>Extraction of 40 to 50 m<sup>3</sup> of roundwood; keep removal of tree microhabitats to a minimum.</p>	<p>Extraction of 50 m<sup>3</sup> of roundwood; removal of tree microhabitats should not exceed a predefined number of habitat points (e.g., 100 to 150).</p>	<p>Extraction of 50m<sup>3</sup> of roundwood of which 10% is of highest quality; removal of tree microhabitats should not exceed a predefined number of habitat points (e.g., 100); ensure selection of suitable habitat tree candidates or creation of conditions that promote the development of tree microhabitats.</p>

### Exercise type: Wood production and nature protection

The aim of this exercise is to extract a given volume of wood (m<sup>3</sup>) by removing a low number of high quality trees. Ecological objectives may require adaptation depending on local conditions. Future habitat tree candidates are not listed in the I+ Software and must therefore be selected based on the expertise of the participants and then jointly discussed.

Beginner	Intermediate	Expert
Extraction of 40 to 50 m <sup>3</sup> of roundwood; keep removal of tree microhabitats to a minimum.	Extraction of 50 m <sup>3</sup> roundwood; removal of tree microhabitats should not exceed a predefined number of habitat points (e.g. 100 to 150).	Remove 70 to 80 m <sup>3</sup> while preserving valuable microhabitats. Ensure suitable light conditions that favour uneven-aged structure richness and regeneration.

### Exercise type: Regeneration

The aim of this exercise type is to either initiate or further enhance regeneration (natural/artificial) in a thinning operation. The exercise can be set up in different ways e.g., as a light thinning to favour shade-tolerant species or using interventions that stimulate regeneration for more light demanding tree species. Exercises can also aim at introducing or training specific regeneration approaches.

Beginner	Intermediate	Expert
Remove a predefined value (in N, m <sup>2</sup> , m <sup>3</sup> ), or percentage (%) of trees, basal area, or volume to promote regeneration.	Remove a predefined value (in N, m <sup>2</sup> , m <sup>3</sup> ), or percentage (%) of trees, basal area or volume to promote regeneration. Seed trees (e.g., 10) of the target tree species are released.	Remove a predefined value (in N, m <sup>2</sup> , m <sup>3</sup> ), or percentage (%) of trees, basal area or volume to promote regeneration. Seed trees (e.g. 10) of the target species are released. For the “advanced” stage, tasks such as achieving a certain revenue / assortment for harvest trees, the retention of habitat trees or stand stability can be added.

<b>Exercise type: Wood extraction</b>		
<p>Skidding trails are used to access stands and individual trees during or following logging operations (harvester or skidding with a winch). In mountainous regions the exercise can be adapted to cable yarding. This exercise combines stand accessibility with silvicultural aims.</p>		
<b>Beginner</b>	<b>Intermediate</b>	<b>Expert</b>
<p>Designate skidding trails with at a distance of e.g. 25 meters.</p>	<p>Perform a realistic or predefined thinning exercise including skidding trails at a distance of e.g., 25 (50) meters.</p>	<p>Perform a realistic or predefined thinning exercise including skidding trails at a distance of e.g., 25 (50) meters. Ensure in the course of the thinning exercise that the marked trees will cause only minimal damage to the remaining trees when removed. Further options that can be included in the exercise are the designation of habitat trees and work safety.</p>

<b>Exercise type: Silviculture (e.g. conversion thinning)</b>		
<p>This exercise is aimed at converting an even-aged stand into an uneven-aged forest. Some parameters that are required in this exercise (stand stability, regeneration, species mixture) are not (yet) integrated in the I+ Software. As a result, they will have to be discussed based on the knowledge of the participants.</p>		
<b>Beginner</b>	<b>Intermediate</b>	<b>Expert</b>
<p>Remove max. 30% of the trees in a way that does not compromise the stand stability.</p>	<p>Remove max. 30% of the trees in a way that does not compromise the stand stability and enhances natural regeneration.</p>	<p>Remove max. 30% of the trees in a way that does not compromise the stand stability and enhances natural regeneration. Try to maximise the opportunities for tree species diversity.</p>

**Exercise type: Economic return (high quality timber removal, accumulation, elite tree selection)**

The goal of this exercise is to do a low-intensity but high-value thinning, focusing on high quality timber. The financial targets might have to be adapted according to the local conditions.

Beginner	Intermediate	Expert
Remove 5 m <sup>3</sup> of timber of high quality timber with a total minimum value of x EUR.	Remove 5 m <sup>3</sup> timber of high quality with a total minimum value of x EUR, removal of a few trees only (maybe also pay attention to regeneration).	Remove 5 m <sup>3</sup> timber of high quality with a total minimum value of x EUR; removal of a few trees only; then: e.g. 'give attention to regeneration' or 'quality assortments with view on timber buyer' or keep harvesting costs low.

**Exercise type: Nature conservation (tree microhabitat preservation)**

The goal of this exercise is to do a low-intensity but high-value thinning, focusing on high quality timber. The ecological value targets might have to be adapted according to the local conditions. Modelling of future tree microhabitats is not integrated in the I+ Software and will have to be discussed based on the knowledge of the participants.

Beginner	Intermediate	Expert
Do a thinning of 20% while removing the least possible tree microhabitats	Do a thinning of 20% while removing a maximum of 100 habitat points.	Do a thinning of 20% while removing a maximum of 100 habitat points. Try to create suitable conditions for future tree microhabitats to originate.

**Exercise type: Regeneration**

The aim of this exercise is to support and enhance tree regeneration in a light thinning operation. It will mainly be suitable for shade-tolerant species. This is not an existing parameter in the I+ Software but is mainly related to competing vegetation and light conditions.

Beginner	Intermediate	Expert
Do a thinning of 20% that stimulates existing and future regeneration.	Release 10 seed trees to stimulate seed germination.	Release 10 seed trees to stimulate seed germination; aim for a basal area of 20 m <sup>2</sup> .

**Exercise type: Thinning from above / seed tree cutting**

A thinning from above aims at removing dominant trees from the canopy in a mature forest in order to obtain a high harvested volume and to benefit the understory and regeneration. Clear-cut with the preservation of a small number of selected quality trees to ensure natural regeneration of the stand. If time is lacking, participants can just mark the seed trees instead of all the trees. The number of seed trees varies according to the species and site characteristics.

Beginner	Intermediate	Expert
Remove 100m <sup>3</sup> from the upper canopy.	Do a clearcut but preserve 60 trees in the upper canopy.	Do a clearcut but preserve 25 seed trees.



Photo: Andreas Schuck