

Forest education

WITH I+ MARTELOSCOPES





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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. Vasyl Lavnyy







Introduction

1.1. Forests and education

Besides providing wood, biodiversity, and recreation, forests are increasingly seen as didactic spaces. Especially for young children, forests are becoming more and more popular as a setting for day care centres, which are especially common in Scandinavia and in the German-speaking world. Also, in other places around the world, the interest in forest schools is growing (O'Brien, 2009, Larimore, 2014).

A Swiss study has shown that also in primary schools, many teachers view forests as suitable for the enhancement of children's personal and social skills (Lindemann-Matthies & Knecht, 2011). Forest schools have been shown to positively benefit the well-being of children (Roe & Aspinal, 2011).

Apart from the many mental and physical benefits children can derive from spending time outdoors, they can also learn from and about the forest. This requires parents, teachers, or instructors not to see the forest as a mere background for education, but as an educational topic on its own.

Moreover, forest education should not be restricted to young children. Research has shown a growing knowledge gap of especially urban populations when it comes to the uses and the long-term effects of forest management (Konczal et al., 2022). Interviews with forest managers have revealed a general willingness to improve communication and reach out to forest visitors, who have been drastically growing in numbers since the COVID-19 pandemic started (Derks et al., 2020; Da Schio et al., 2021). These novel visitors often have little knowledge of and acceptance for forestry, which can make communication challenging.

Simultaneously, the public pressure surrounding "green topics" has increased and while sometimes leads to contradictory societal demands (cf. Aggestam et al., 2020), the general environmental awareness has grown considerably, according to many forest managers.

In the eyes of many foresters and researchers, this has led to a situation where on the one hand people are more than ever aware of the crucial importance of forest and nature for a vast array of ecosystem services, but on the other hand have lost the understanding of the human management interventions that are often needed to safeguard the provision of these services (Konczal et al., 2022; Derks et al., 2020). As an example, many people know that wood is a more sustainable building material than concrete or steel, but still protest against



cutting trees for timber. Majestic oak forests which have been managed for centuries are often perceived as natural while in reality without human intervention most of them would turn into forests almost exclusively composed of beech trees.

The often one-sided media images of environmental destruction and deforestation contribute to the negative view of people's impact on forests, despite many positive evolutions in the field of forestry and nature conservation. Education can help people reconnect to the forest and its diverse functions

1.2. Why this document?

It only takes a visit to your local bookstore or a peek at Instagram to realise this: more and more people long for the outdoors and wilderness. The world is becoming ever more urbanised. The increasingly artificial universe in which we live, where even contacts are becoming increasingly digitalised, has led to an unparalleled surge in escapist sentiments. Van life, tiny houses, guerrilla gardening, bush-crafting, etc., countless trends respond to the urge that many feel to retrieve a sense of authenticity and simplicity that, while seemingly free and accessible to all, is often obscured by the infinite stimuli bombarding us.

Despite these trends, younger generations still overwhelmingly seem to appreciate nature's gifts from the comfort of their own homes rather than going out and experiencing the real deal. A study in Bonn has shown that people under the age of 25 made up but a fraction of the forest visitors. Nature is experienced through a screen, forest-based products consumed in the form of packaging from online orders.

On Netflix or YouTube you can watch hours and hours of nature footage, but you won't have the same immersive experience you would in a woodland. The sensation of a warm spring breeze on your skin, the speckled light of sunrays piercing through a green summer canopy, the earthy scent of colourful foliage slowly decomposing in autumn, and the real sounds of birds, wind, and creaking trees. Or the opposite: the sensation of sheer silence on a foggy winter's day in the forest, a feeling which has become utterly rare in our modern world full of incessant auditory and visual stimuli. The joy of seeing an elephant or a Siberian tiger on a screen is easily outweighed by the excitement everyday real-world observations: the brilliant blue fathers on the wings of a jay, the eerie cry of a tawny owl, the rattle of a woodpecker, or the curious look of a fox who spotted you long before you spotted it.





1. View of Bonn and the Kottenforst (photo: Jakob Derks).

Apart from the escapist trends, there has also been an upsurge in environmental awareness, illustrated by, among others, the Fridays for Future protests which have spread around the globe. Policy makers have shown a growing interest in the role of forests to mitigate a number of environmental issues we are facing. But also here, the link to the reality on the ground is sometimes lacking. We all support the use of renewable materials such as wood, but oppose its production process, that is, if we are aware of it at all. Everybody knows that wood comes from trees, but how? How old is a tree when it is harvested for wood? How is the wood extracted from the forest? And does this harm nature?

One way to find out: go outside and explore the forest! But where do you begin? A marteloscope is a good starting point. This document will briefly cover the following topics:

- What is forest management about?
- What are marteloscopes?
- How can marteloscopes be used in training and education?



1. Forest management and marteloscopes



2. Forest stand in near Kiev in Ukraine (photo: Vasyl Lavnyy).

2.1. Why are trees cut?

In order to survive, trees need light. Some species need more light than others. In much of Central and Western Europe, the dominant tree species is beech (*Fagus sylvatica*). Beech can tolerate a lot of shadow both as a seedling and as a mature tree, and thus tends to outcompete species that are more light-demanding, such as oak (*Quercus robur*). In a system without human interference, natural calamities such as storms, fires or diseases can create open spaces in the forest where light demanding plants can thrive. Humans can mimic this process by selectively cutting trees, which is called "thinning". Doing this not only creates varying light conditions but also provides wood, a renewable resource of which the average European consumes 1m³ of annually. Wood is used in countless products, often without the consumer being aware of it. From houses and furniture to energy and food products; wood products can be found anywhere. Increasingly, new technologies allow wood-based products to replace more polluting alternatives, for instance through bioplastics or wood fibres. Forest also provide products other than timber, such as mushrooms or berries.



Moreover, trees play an important role for our physical and mental wellbeing. They produce oxygen and clean air. People like to walk, cycle or play in them. The green natural surroundings have a calming effect and can help people cope with stress.

Humans have utilised forests since we originated some 300.000 years ago. During the last ice age, much of Europe was covered in snow and ice. Many regions to the south had a tundra climate, where trees could hardly survive. When the ice started to retreat over 10.000 years ago, some of the first trees that colonised these empty lands were used (and maybe even introduced) by people. Hazelnuts, now famous for being one of the main ingredients in your favourite chocolate spread, were already dispersed by people thousands of years ago. Humans and forests thus share a long history.

All of this means that we have to use our natural resources wisely. Luckily, the forest lends itself perfectly to a multifunctional approach. There are essentially two methods of forest management. 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.





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



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



2.2. What are 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-tonature 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 oldgrowth phases and corresponding habitat structures have become rare. Conservation of 5. Deadwood brings life into the forest. biodiversity in commercial forest stands is thus linked to retaining such microhabitat structures.



Tree microhabitats 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 tree microhabitats 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 tree microhabitats.

The tree microhabitats 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. What is a marteloscope?

Marteloscopes are 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 (tree diameter at breast height – ca. at 130 above ground, 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 <u>I+ Software</u> 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.



7. Visiting a marteloscope (Photo: Jakob Derks).



2.4. What is 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 asses 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

Want to learn more about...

How to set up a marteloscope?

• http://iplus.efi.int/uploads/Marteloscope_Guidelines_Setup.pdf

How to use the I+ Manager?

• <u>http://iplus.efi.int/uploads/20200319_UserManual_I%2BManager.pdf</u>

How to use the I+ Trainer?

• http://iplus.efi.int/uploads/l%2BTrainer_Tutorial.pdf

Tree microhabitats?

 <u>http://iplus.efi.int/uploads/Tree%20Microhabitat%20Catalogues/Catalogue_Tree</u> <u>Microhabitats_EN.pdf</u>



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, factbased 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.



8. Using the I+ Trainer on a tablet (Photo: Jakob Derks).



9. Overview of possible exercise aims for different target groups.

	Primary school	Aim: discover the forest
		• Find a mushroom, a woodpecker hole, a broken branch
		 Look for the biggest tree in the forest
	Secondary school	Aim: introduction to forestry, linked with school classes
		 Connection to geometry classes (calculate volume of a tree)
		 Connection to biology classes (photosynthesis and tree growth)
		 Connection to geography classes (wood supply)
	Life sciences	Aim: create awareness of the use of forest management
	Bachelor's	Determine tree species
		Spot different microhabitat types
		Look for traces of human interventions
	Forestry Bachelor's	Aim: get acquainted with the principles of thinning
		Determine tree species
		Spot different microhabitat types
		Simulated thinning exercise in one quadrant
	Life sciences Master's	Aim: understand trade-offs between nature, economy and recreation
		Thinning exercise in one quadrant
		Microhabitat inventory (for a new marteloscope)
	Forestry Master's	Aim: understand trade-offs between nature, economy and recreation
loc		 Simulated thinning exercise on the whole site
Scho		Tree inventory (for a new marteloscope)
•,	Recreationist	Aim: create awareness of the use of forest management
uo		Select some trees with valuable stems
eati		 Select some trees with high biodiversity values
ecre		 Look for traces of human interventions
Re		
	Forestry professional	Aim: understand trade-offs between nature, economy and recreation
		Simulated thinning exercise on the whole site
tice	Nature professional	Aim: understand trade-offs between nature, economy and recreation
rac		Thinning exercise on the whole site
8	Daaaankan	Alexander and the second
	Researcher	Aim: create awareness of forestry work on the ground
rch		Select some trees with valuable stems
sea		Select some trees with high blodiversity values
Re		Simulated thinning exercise on the whole site
	Policy maker	Aim: create awareness of forestry work on the ground
		Select some trees with valuable stems
Ś		Select some trees with high biodiversity value
Poli		Simulated thinning exercise in one quadrant



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?

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

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

4.1. Primary school

Welcome to the forest! If you look around you, you will see that all the trees have a number written on the stem. Together, all the numbered trees form a 'marteloscope'.

The forest is important for people but also for nature. Sometimes trees are cut to produce wood. Everybody has things made of wood at home. Can you think of some examples? Name three wooden objects in your home:

1) 2) 3)

Cutting trees is necessary if people want to use the wood, but it also allows more sunlight to reach the ground. This helps the young trees to grow, as trees need light for that. When seeds of the trees fall to the ground and start growing, this is called *natural regeneration*. They assure the future of the forest. Can you spot any small trees?

If you look at the map of the marteloscope, you can see circles in different colours. Each colour represents a different types of trees. Can you name some species that grow in this forest?

.....

The forest is home to many plants, animals, and fungi. We say that the forest offers a *habitat* for many species. Have you already seen an animal here? Which animals do you think live in this forest?

.....

All the animals have an important role in the forest, but one very special animal is the woodpecker. Woodpeckers are famous for making holes in the forest with their sharp beak. They do this to reach insects that live under the tree bark, and also to create homes to lay their eggs. When they abandon their holes, these are often used by other animals: owls, bats, squirrels, pine martens.... Find two trees with woodpecker holes and write down the numbers.

1) Tree #

2) Tree #





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

4.2. Secondary school

Welcome to the forest! If you look around you, you will see that on a rectangular area of one hectare, all the trees have a number written on the stem. This area is called a *marteloscope*. The concept originates in France and the name comes from the French word '*martelage*' (marking trees) and the ancient Greek word '*skopein*' (to look).

In a marteloscope, all the tree data is considered. Specifically, we record 1) tree species, 2) tree diameter and height, 3) tree position, 4) wood quality, 5) microhabitats, and 6) deadwood. Why precisely do we need this data?

In a marteloscope, people can get an insight in forest management. You may think that forests don't need management. And to a certain extent that is true. That is why all over Europe, more and more forests are simply left to nature. However, forests also have other functions that are of importance to us, humans. The first one is wood production. The average European useds1m³ of wood each year.



"Make a sketch of a cube of 1m³. How many litres of water would fit in this cube?"

Which wood products would make up your 1m³ cube?

1)	 	•••	 	 		•••	•••	•••		•••	•••	 	 •	•••	 •••	 •	•	•••	•••	•••	 •••	•••	•••		 •••	 	
2)	 	•••	 	 	•••				•••			 	 •		 	 •	•							•	 	 ••	
3)	 		 	 								 	 		 						 				 	 	

Stand data

Soil, temperature, and precipitation influence which tree species can grow in a certain place and determines how fast they will grow. If you look at the data sheet of the marteloscope, you can find this information.

Tree diameter and height

By calculating the tree height end the diameter at breast height, we can make an approximate calculation of the wood volume. The forest is important for nature but also for people. Sometimes trees are cut to produce wood. Wood is a renewable resource. Renewable means that it does not get depleted if it is used wisely. Wood is used in a variety of products.

All the trees in this marteloscope have been measured in order to calculate the volume. Most tree stems are roughly cylindrical up to the crown. *"How do you calculate the volume of a cylinder?"*

 $(V = \pi^* r^{2*} h)$

"Find a big tree (Tree #.) and try to calculate the volume".

1) Tree number:

2) Wood volume:

Cutting trees is necessary for wood production, but it also allows more sunlight to reach the ground. Sunlight provides trees with the energy for photosynthesis. This is the process that allows trees to grow. Doing so, they also produce the oxygen we breathe. Here you see the chemical formula behind photosynthesis. *"What do the molecular formulae stand for? Please write down their full name."*

6 H ₂ O	+	6 CO ₂	\rightarrow	C ₆ H ₁₂ O ₆	+	6 O ₂
	+		\rightarrow		+	



Sunlight is also crucial for *natural regeneration*; the spontaneous growth of young seedlings. In very dark forests, only few species can regenerate. Natural regeneration assures the future of the forest. Can you spot any? If the desired tree species are absent, one can resort to *artificial* regeneration. Which practices do you think this includes?

Tree species

Most forests contain more than one tree species. Each species has specific characteristics related to wood use, impact on the soil and biodiversity. In summer, you can recognise many species by their leaves. In winter, you have to determine them by shape, bark texture or buds.

If you look at the map of the marteloscope, you can see circles in different colours. Each colour represents a different tree species. Which species grow in this forest?



Tree species diversity does not only contribute to the forest biodiversity, but also to the forest *resilience*. Just like people, trees can also get sick when they are attacked by insects, fungi or viruses. If all the trees belong to the same species, there is a higher chance that they will all be affected. But those trees that belong to another species will likely stay healthy and thus preserve the forest. Different tree species also have different sensitivities to frost, drought, wind etc. In general, we could say more tree species equals more resilience.

Wood quality

There are various quality classes of wood. This depends on the tree species, the size of the tree, and the absence of lumber defects.



Firstly, not all tree species are the same. Some grow fast, some grow slow. Some produce heavy hard wood, other light or soft wood. Some wood types are durable, others decay relatively fast. Small trees or trees with a lot of curves, twists and damaged spots will most likely be used for firewood, energy wood or pulp. Slightly better quality stems can be used for industry wood for the production of boards. Higher qualities may end up as sawn wood or lumber. These are beams and planks, used to build houses or furniture. Finally, the highest quality wood is typically used for *veneer*. The differentiation in wood use for different wood qualities is call *cascading use*.

Coniferous species like spruce and pine are mostly used for construction lumber, since they produce homogeneous long stems that are strong and light at the same time. Broadleaf species like beech or maple are often used for flooring or furniture. Durable broadleaves, like oak and chestnut can also be used outside for doors, terraces or fences.



11. Potential uses for oak wood.





12. Potential uses for spruce wood.

Everybody has things made of wood at home. "Can you think of some examples for the following wood quality categories?"

1) pulp:	
2) lumber:	

3) veneer:

If a tree has too many defaults it cannot be used for timber production, but such trees can have a very high ecological value. Dead branches, broken crowns, fungal decay, etc., are all negative for wood quality but positive for biodiversity.





13. Low wood quality can indicate high biodiversity.

Tree position

In order to determine the position of a tree in the marteloscope without a GPS, we need to calculate the angle to and the distance from the centre of the quadrant. *"Can you find the magnetic north with a compass?"*

Tree microhabitats

The forest is also home to many other plants, animals and fungi; it offers a *habitat* for many species. All these species together form an (ecosystem).



14. Selection of tree microhabitats lists in the tree microhabitat catalogue (available in different languages).



All the animals have an important role in the forest, but one very special animal is the woodpecker. Woodpeckers are famous for making holes in the forest with their sharp beak. They do this to reach insects that live under the tree bark, and also to create homes to lay their eggs. When they abandon their holes, these are often used by other animals: owls, bats, squirrels, pine martens..... *"Find two trees with woodpecker holes and write down the numbers."*

1) Tree #.

2) Tree #

Deadwood

It may sound contradictory, but deadwood brings life to the forest! Countless species rely on dead trees for their survival. Fungi break down the wood and recycle the nutrients. Some insects lay their eggs in deadwood, while their larvae feed birds and mammals. A forest with deadwood offers food and a home to many plants and animals.





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