

# Forest and Timber Management Guideline for Teachers

## Abstract

Forest areas need to be managed. Many landowners engage a forest management company for this.

In this task students calculate, as employees of a forest management company, the volume of wood in a forest area as well as the necessary amount of trees for the afforestation of a felling site. Both are services requested from the private owner of a piece of land. From a list of plant species students can select young trees and give an evaluation of the costs to be expected.



Their product will be a written report summarising the most important results, possibly containing diagrams and sketches. They will present their results to their co-workers in a short presentation.

When working on this task, students have to use and comprehend the data provided in tables, to apply given formulas and give reasons for it, to perform simple calculations, elaborate strategies and summarise results.

|                      |   |
|----------------------|---|
| <b>Age group:</b>    | 12–14 years, but can be adapted to other age groups   |
| <b>Target Group:</b> | Lower Secondary Education   |
| <b>Discipline:</b>   | Cross-disciplinary between Mathematics and Science (Biology)  |
| <b>Key Terms:</b>    | Data analysis, surface and volume calculation, mathematical modelling in the broadest sense, divisibility, linear equations.<br>Forest ecology, biodiversity, nature conservation, succession of plant communities, tree height, tree age.<br>Optional: graphs or thematic charts (make your own tree vegetation chart) |
| <b>Time:</b>         | Two – three lessons (100 -150 minutes).   |

## Student Task

You are employees of the Austrian Bundesforste (a company managing natural resources, mainly focusing on forest management, on behalf of the Austrian federal government) and are responsible for the forest and timber management of a privately owned piece of land.

The landlord wishes the deforestation of a forest area as well as the afforestation of a felling site. For this, calculations are necessary.

- Do some literature studies to collect background information about forests in your area to model the landlord's land. Investigate the plant and tree diversity, and together with literature studies estimate whether the forest and plant communities are of a pioneer type, an intermediate type or a climax type.
- Table 1 provides the diameters at breast height (DBH) and total height of twenty 60-year-old spruces in the forest area to be deforested.

|        | F1   | F2   | F3   | F4   | F5   | F6   | F7   | F8   | F9   | F10  |
|--------|------|------|------|------|------|------|------|------|------|------|
| DBH    | 15,1 | 15,1 | 15,3 | 15,4 | 15,5 | 16,2 | 16,7 | 16,7 | 17,2 | 17,9 |
| Height | 10,3 | 10,8 | 11,4 | 11,2 | 11,9 | 12,8 | 12,4 | 13,1 | 14,3 | 14,8 |

|        | F11  | F12  | F13  | F14  | F15  | F16  | F17  | F18  | F19  | F20  |
|--------|------|------|------|------|------|------|------|------|------|------|
| DBH    | 18,4 | 19,8 | 19,9 | 20,2 | 20,4 | 21,6 | 22,6 | 23,5 | 23,9 | 24,5 |
| Height | 15,1 | 15,7 | 15,7 | 16,3 | 16,1 | 16,9 | 17,8 | 18,2 | 19,5 | 19,8 |

Table 1 Diameters at breast height (in cm) and height (in m) of 20 spruces (age: 60 years)

Estimate the volume in  $m^3$  (cubic meter) of this stand. To do so, use this formula (customary in forest management):

$$V = G \cdot H \cdot F$$

$G$  is defined as the sum of the tree's cross section surface at breast height,  $H$  as the medium height, and  $F$  as the shape number. Depending on the tree growth circumstances, the latter lies between 0,4–0,55. The form number of the respective tree species can be taken from tables. With respect to this stand, the shape number lies between 0,46 and 0,48.

Why is it necessary to multiply with a shape number? What is being calculated when the shape number is left out?

- The felling site,  $20m \times 100m$ , is to be afforested with spruces, firs and beeches. How many of the respective trees are necessary for this? The planned distances between the trees can be gathered from table 2.

| Tree Species                            | Recommended planting distance between trees |             |
|---|---|-------------|
|   | between rows                                | within rows |
| Spruce ( <i>Picea abies</i> )           | 2,5   | × 1,5       |
| Fir ( <i>Abies alba</i> )               | 2,5   | × 1,5       |
| Common Beech ( <i>Fagus sylvatica</i> ) | 1,5   | × 1         |

Table 2 Recommended planting distance between trees (in m) (Landwirtschaftskammer Oberösterreich, 2011)

- *The costs for the young trees are listed in table 3. How much will it cost the landlord to buy trees for the afforestation of the felling site?*

| Species                                 | age/height (cm) | price |
|---|-----------------|-------|
| Fir ( <i>Abies alba</i> )               | 4-years         | 0,60  |
|   | 5-years         | 0,65  |
| Spruce ( <i>Picea abies</i> )           | 3-years         | 0,43  |
|   | 4-years         | 0,48  |
|   | 5-years         | 0,55  |
| Common Beech ( <i>Fagus sylvatica</i> ) | 20–40           | 0,63  |
|   | 30–50           | 0,74  |
|   | 50–80           | 0,97  |
|   | 80–120          | 1,69  |

**Table 3 Excerpt of a list of plant prices (in Euros) (Tiroler Landesforstgärten, 2014)**

*The results should be presented in a report, which will be given to the landlord. To inform all future employees, your summarised results should be presented during the next morning meeting. The results should be followed by discussion, in light of the background information, on how the deforestation/afforestation strategy will affect the forest ecology in the long term. Eventually you can also draw on or connect your discussion to nature conservation policy in your area.*

### **Inquiry Learning Dimensions**

- Inquiring minds
- Applying mathematics to real life problems
- Understanding how mathematics are utilised in the world of work
- Students try to solve problems and use their knowledge to find solutions
- Students reflect on results and processes
- Students develop their own understanding
- Students explore the world of work
- The context is meaningful and practical
- The formulation of the question allows different problem solving strategies
- The learners are acting actively and with sole responsibility
- The task supports collaboration and communication

### **Inquiry Learning: Additional Remarks**

The students work in groups with defined data (in tables) on a specific problem. They have to analyse data, process information, give reasons, make decisions and perform calculations. The mathematical requirements are the use of formulas, modelling in the broadest sense and mathematisation, as well as calculations of quantity and costs.

The science requirements are searching information on plant and tree diversity (literature study), analysis of information in terms of the types of plant and trees communities (pioneer, intermediate or climax types), as well as discussing on how the chosen strategies will influence the forest ecology in the long term.

### **World of Work Dimensions**

The task has a direct connection to the world of work. Students play a certain role, perform typical work activities and create an authentic product.

**Context:** The task is taken from the field of forest and timber management.

**Role:** Students are employees of the Austrian Bundesforste and support landowners in forest management tasks.

**Activity:** Students calculate the volume of wood in a stand of trees, based on provided, authentic data. To do so, they have to use and comprehend a formula that is commonly used in forest management. With the help of data from another table, they then calculate the number of young trees needed for afforestation and elaborate an afforestation strategy. Through a selection of trees and their cost listings they are able to calculate the costs of afforestation. They summarise their results, create diagrams (optional) and present their results to their peers. They then discuss their finding from the science perspective. Possible discussion points are for instance, how the deforestation/afforestation strategy will affect the forest ecology or how the strategy would help in promoting the nature conservation long-term policy (if there is any such policy). To do so the students need to draw from their pre-knowledge or to seek for relevant information beforehand, such as background knowledge on the succession from pioneer to climax plant communities.

**Product:** Students summarise their results in a report, which the landowner will receive for information purposes. In a short presentation students present their results to their co-workers.

**Respective Occupation:** Employees of forest management companies and civil engineering companies, foresters.

### **Potential for Professional Development:**

The task is very suitable for professional development because various dimensions of inquiry learning are realised and all required aspects of the world of work are included.

### **Further Information**

<http://www.efi.int/portal/home/> (European Forest Institute)

<http://bfw.ac.at/>

<http://bfw.ac.at/rz/wi.home>

<http://bfw.ac.at/030/pdf/lernbehelf.91-142.pdf>

<http://www.fastort.at/index.php/downloads/57-forstkurs-fuer-neueinsteiger-und-waldpaedagogen>

[http://bfw.ac.at/ort1/Vortraege\\_als\\_pdf/Vortraege\\_Neueinsteiger/Waldbau\\_Aufforstung\\_PDF.pdf](http://bfw.ac.at/ort1/Vortraege_als_pdf/Vortraege_Neueinsteiger/Waldbau_Aufforstung_PDF.pdf)

<http://www.bundesforste.at/produkte-leistungen/dienstleistungen/waldbewirtschaftung.html>

<https://www.tirol.gv.at/umwelt/wald/>

## **Potential adjustments to other age groups:**

### 10-12 years

The part of the task where the calculation of volume is, can be left out.

The next parts on calculations of trees and costs can be used without any changes. For further simplification the prices of young trees can be rounded. The focus for this age group is how to formulate information in a mathematical equation.

The requirement on literature study of background information on trees and forest can be simplified, as well as the discussion part on forest ecology and nature conservation strategy.

On the other hand, it is also possible to extend the task to include estimation of tree heights for instance by using similar triangle methods. Examples of other age-appropriate methods are given in <http://www.wikihow.com/Measure-the-Height-of-a-Tree>.

Another possible extension of the task is the study of annual growth ring patterns of cut trees to estimate the age of trees and forest.

### 14-18 years

For older age group the mathematical part of the task can be extended to more complicated graph presentation and analysis, as well as using trigonometry in case the measurement of tree height is included.

The task can be also adjusted to the older age group by deepening the connection with science for instance by including more aspects of the forest ecology such as biodiversity and plant physiology. The study of the annual growth ring patterns of cut trees for instance, can be expanded to look for the influences of different climate changes during the life time of the trees in addition to the estimation of the age of the forest (as for younger age group).

## **Potential adjustments for other countries:**

In principle no adjustments are necessary. Instead of the Austrian Bundesforste any other forest management company of a country can be selected and the price list for the plants can be replaced by one from a regional supplier. The fir-sprout-beech forest for afforestation can be replaced by a location-appropriate species for forest rejuvenation, which represent typical species for this altitude, latitude and terrain.

The links provided in "Further Information" can be adapted by changing them or adding your own links that give background information about local plants and forests.

## **Suggestion of questions to be discussed:**

How large is the forest area that the 20 trees are taken from?

How are shape numbers determined?

How are the listed distances between trees calculated?

Which afforestation patterns are usually implemented by foresters?

Are there any guidelines for the selection of young plants?

## Example of lesson plan

### 1. Lesson

5 min Hand out student tasks; divide students in groups (3-4 persons)

Students read information and try to comprehend the task.

10 min Discussion of the task in class; teacher could show images of felling sites and afforestations; discussion of student questions; working out first steps

35 min students work on the task (in groups); teacher supports them as an adviser

### 2. Lesson:

5 min Short repetition of the task in class

Joint answering of arising questions, discussion of unclear aspects

20 min students work on the task (in groups); teacher supports them as an adviser

5 min Students summarise their results and write the report

10 min morning meeting: individual students present their results and discussion

10 min plenary discussion on the presentation: students give each other feedback

Final activity: How did you perceive the last two lessons? (Students' feedback on the task)

*Homework:* Students check another group's report; to be discussed next lesson.

**Remark:** The teacher may want to include time for students to get some background knowledge in science as well for the discussion purpose. In that case, the lesson plan needs to be adjusted accordingly.

## Material available

Student handouts

Several brochures on websites

## References

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Abgerufen am 24. Oktober 2014 von

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