



freeland

Promoting STEAM through participatory urban regeneration

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Laboratory

Plant Biodiversity Detectives

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FREELAND laboratories follow the structure of Inquiry Based Learning, in 5 steps (orientation, conceptualization, investigation, conclusion and discussion), and for each step we suggest activities and methodological approaches that are engaging for the students such as brainstorming, hands-on, creative works. The activities described in the laboratory are suggestions that teachers can adapt or replace with similar activities suitable to students' age and school type.

Laboratory	Plant Biodiversity Detectives
Duration:	2-3 hours outdoors & 2 hours indoors
Tools:	Pocket guides for plant identification or dichotomous keys for grass and forbs and trees, or mobile phones for Identifying Apps. Pen and notes Sampling tools for plant materials (see below) Excel for calculations (or calculators)
Technologies:	Mobile phones for Apps such as PlantNet, iNaturalist, Google Lens.
Subjects:	Science (Biology), Maths
Students' age	Any
School type	Any
Disciplinary contents:	This laboratory is about the assessment of Plant Biodiversity in an urban space (garden, park, abandoned area with spontaneous vegetation). In some anthropic places such as parks and gardens, plants have been introduced, while wild spontaneous plants spread thanks to the capacity to colonize environments and sometimes to withstand incredible conditions (e.g. high temperatures of the asphalt, drought). This laboratory aims at investigating the plant biodiversity of urban places by applying scientific methods of sampling and evaluation and understanding which species are present and their characteristics that allows them to live in the growing environment. The laboratory includes the calculation of formulas for the

	Simpson’s biodiversity index (D), that are clearly explained, for which the math teacher can give students support.
Learning objectives:	<p>Students will be able to</p> <ul style="list-style-type: none"> ● Make observations of the plants in urban environment ● Do hands-on manual works outdoors (sampling) ● Learn botanical terminologies ● Calculate formulas and make graphs ● Discuss the mathematical results and make relationships with the characteristics of the species and the environment

For each phase of the IBL we provide a description of the suggested activities.

Orientation

Duration:	0,25 hour outdoors
Tools:	No specific tools
Technologies:	No
Subjects:	Science (Biology)
Method:	Brainstorming

The teachers take the students outdoors to the neglected built space (e.g. square, ancient wall, tree line road) where plants grow, and invite them to observe the plants. Circle Time will push them to answer questions related to the plants in the place (variety of species, ability to grow), for instance. If teachers have short time, they can give students 2 minutes to answer a couple of questions in paper, for instance:

“Do you know some of the species here?”

“Do you consider this place rich in biodiversity?” (a definition of biodiversity should be given)

“Is biodiversity a value in this place? Why? How biodiversity can help the regeneration of the place?”

Students should recall their prior knowledge to answer questions.

Terminology:

- *Biodiversity in a specific area: all the different kinds of life – the variety of animals, plants, fungi, and even microorganisms like bacteria.*
- *Autochthonous: typical of the country and the local climate*
- *Allochthonous: imported from a different country or climate, alien.*
- *Invasive: a species with aggressive behavior: high germination capacity and highly competitive, surpassing the local species.*

Conceptualization

This phase concerns the creation of questions aimed to assess the biodiversity of the area, that will be answered during the investigation phase.

Duration:	0,25 hours outdoors
Tools:	No specific tools
Technologies:	No
Subjects:	Science (Biology)
Method:	Brainstorming

Following orientation, the teachers invite the students to raise questions linked to the assessment of plant biodiversity or guide them by posing questions such as,

“How can I measure biodiversity?”

“What is the richness of species (biodiversity) here? What if compared to a natural lawn or a forest?”

Investigation

The investigation includes one activity that will answer the question posed. Teachers can also make a complementary activity that will help students to acquire knowledge and terms about plant characteristics.


Question to answer - “How can I measure biodiversity?” “What is the richness of species (biodiversity) here? What if compared to a natural lawn or a forest?”


Duration:	2 hours outdoors
Tools:	Tools for plant sampling (see sampling methods 1-3), camera
Technologies:	Apps for plant identification such as iNaturalist, PlantNet, Google Lens
Subjects:	Science (Biology), Maths
Method:	Hands-on. The investigation concerns the following activities sampling, identification of the species and data acquisition


In order to assess biodiversity, students need to collect data in the area such as the number of species and the abundance of specimens per species. Sampling and species identification can be done during Science class while data organization and analysis can be done during Math.

Planning and performing sampling

There are three sampling methods that can be used depending on the type of vegetation: if the area is a lawn or similar, there are two sampling methods for grass and forbs (choose between Method 1 or Method 2). For trees, Method 3 can be used.

Method 1 for grass and forbs:	Sampling “quadrats” can be used in the case of vegetation growing at different densities.
Tools:	One or more sampling quadrats (e.g. 25*25 cm or similar) 
Sampling procedure:	Place randomly the sampling quadrat on the grass cover to identify the species inside the quadrat.

	Repeat the sampling at least three times.
Method 2 for grass and forbs:	<p>Linear transect can be used in the case of highly dense vegetation or along pedestrian paths.</p> 
Tools:	<p>Measuring tape or a long string (e.g. 2 m long) One long pin (or a screwdriver) and one paper holed circle of 2 cm inner radius per group of students</p>
Sampling procedure:	<p>Place the measuring tape or the string on the area that you want to sample. Put the paper holed circle with the pin inside every 50 cm along the tape and identify the species inside the holed circle. Repeat the sampling at least three times, if possible.</p>
Method 3 for woody species	Circle sampling plot

	
Tools:	String or measuring tape of 5 m
Sampling procedure:	<p>Take the string and randomly choose a tree in the area. From that tree, draw an ideal circle of 5 m radius with the tree at the center.</p> <p>Repeat the sampling at least three times, if there are many other trees.</p> <p>Consider all the trees and shrubs included in that circle.</p>

Trick: No time outdoors, limited time to identify species onsite.

Tip: Students can cut all the plants (from the base) and for woody species, samples of leaves and flowers and fruits, if possible, put them into a plastic bag to take them to school. In this case, they need scissors, plastic bags and a big fridge bag. Plants can be collected to make a herbarium, for this, specimens must have all elements required for their identification, if possible, flowers and fruit but also

the underground parts. For woody species, the sample should have parts of plants where the characteristics are discernible (e.g. leaf pattern).

If a species is known to be rare, it should only be collected after ensuring there is a large population in the specific area.

Students are divided into small groups along the linear transect (e.g. 2) and bigger groups (3-4) for quadrats and circles to perform the sampling and the identification of the species.

Identification of the species and data acquisition

Each group works on their own samples (onsite or in the classroom).

Identification methods (choose one or more):	
<p>1) Dichotomous keys/Pocket guides</p>	<p>These should be in a local language, therefore a search on the internet is needed to find useful tools. N.B. The following link refers to plants in UK but some species might be also found in the partnership countries https://fairfaxgardening.org/wp-content/webdocs/ref/IdentifyTrees-FFX.pdf</p> <p>The following <i>Dryades</i> website allows access to interactive identification tools devoted to plants, fungi and animals, to archives of digital images and to important database on the biodiversity of Italy: https://dryades.units.it/home/?lang=en</p>
2) Apps (e.g.):	iNaturalist, PlantNet, Google Lens

Each group fills in a table like the following with the name of the species and the number of individuals found in the sample.

Number of Quadrat/Transect point	Species	Number of individuals (n)
1	Erigeron sumatrensis Retz.	3
1	Festuca spp.	2
1	Papaver rhoeas L.	1
1	Chondrilla juncea L.	4
1	Sum	10
2	Erigeron sumatrensis Retz.	2
2	Festuca spp.	4
2	Lolium perenne	2
2	Taraxacum officinale	1
2	Papaver rhoeas L.	2
2	Sum	11
3	Festuca spp.	5
3	Taraxacum officinale	3
3	Papaver rhoeas L.	3
3	Sum	11

They can transcribe the numbers into an Excel worksheet or in the notebook for further elaborations (see Conclusion).

One nice specimen per species can be placed inside newspaper sheets and put to dry in a press.

In addition, students can search information about the species (to know if the species is originally from a different country, if it is considered invasive etc.) and they may use all information to produce a description card that can be shown in the neglected space as in a botanical garden.

Trick: Difficulty to understand the meaning of some specific terms in the dichotomous keys or in the pocket guides.

Tips: Students can access information to acquire terminology such as concerning the shape of the leaves, plants and grasses, glossary (e.g.):

<https://www.exploringnature.org/db/view/Deciduous-Tree-Identification-Using-a-Dichotomous-Key>

https://bsbi.org/wp-content/uploads/dlm_uploads/BSBI-Intro-to-grasses.pdf

<http://bhort.bh.cornell.edu/tree/glossary.htm>

Information on European tree species characteristics:

<https://forest.jrc.ec.europa.eu/en/european-atlas/atlas-download-page/>

Conclusion

This phase concerns the analysis of the data to obtain the results that will be discussed in the next phase.

Duration:	1 hour indoors
Tools:	Pencils and notes
Technologies:	PC or notebook
Subjects:	Math
Method:	Simple data analysis (sums, ratios)

Biodiversity can be expressed by two terms:

- 1) **Richness** of species, represented by the number of species per sample.
- 2) **Evenness**, as a measure of the relative abundance of the different species making up the richness of an area.

The data collected on the field can be processed to calculate Simpson's biodiversity index (D) which takes into account the number of species present (richness), as well as the relative abundance of each species (evenness).

It can be calculated in this way:

$$D = \frac{\sum n*(n-1)}{N*(N-1)}$$

where “n” is the total number of individuals of a particular species and “N” is the total number of individuals of all species. The greater the value, the greater the sample diversity. In this case, the index represents the probability that two individuals randomly selected from a sample will belong to different species.

For instance, for the first quadrat, the following results will be obtained:

Species	Number of individuals (n)	n*(n-1)
Erigeron sumatrensis Retz.	3	=3*(3-1)=6
Festuca spp.	2	=2*(2-1)=2
Papaver rhoeas L.	1	=1*(1-1)=0
Chondrilla juncea L.	4	=4*(4-1)=12
Sum	N = 10	20

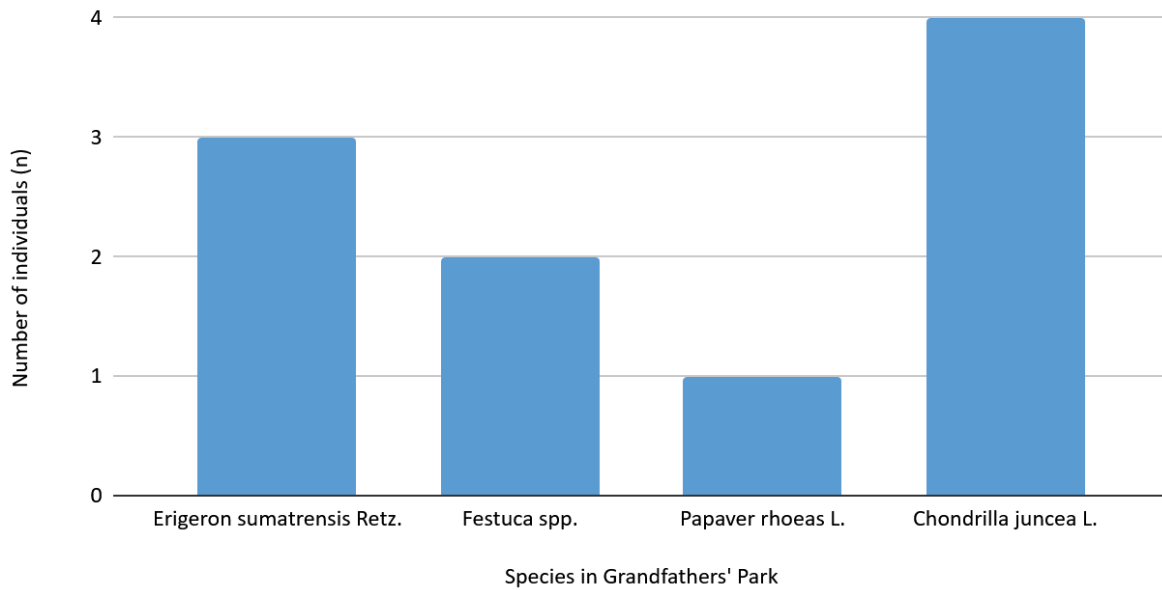
$$D = \frac{20}{10*(10-1)} = \frac{20}{90} = 0,22$$

Then, the students will insert the data found in different areas in the platform to get the representation of the results in a graph.

Species in the specific Park	Number of individuals (n)
Erigeron sumatrensis Retz.	3
Festuca spp.	2
Papaver rhoeas L.	1
Chondrilla juncea L.	4

Name of the Park, Country	Simpson's biodiversity index (D)
Parco Est, Italy	0.22

Number of individuals (n) rispetto a Species in Grandfathers' Park



Then, at school or as homework, students search information about the species, for instance, if the species are autochthonous, allochthonous, invasive etc.

Discussion

In this phase students reflect on the findings. They should be able to answer the original question and reflect on it.

Duration:	1 hour indoors
Tools:	Pen/notes/Powerpoint
Technologies:	PC
Subjects:	Science (Biology), Math
Method:	Brainstorming

Students, in groups, answer the questions of the **worksheet “Key Findings on Biodiversity?”** providing their own opinion about the importance of biodiversity and finding a method to improve biodiversity in the area.

The elements of biodiversity that are considered important for the area will be listed to be included in the 3D model.

Outcomes:

- 3D visualization of the project (one student group will recreate the place virtually with the support of the **Platform**).
- Labels (optional) of species that can be placed in the area with the description of the species, suggest seed bombing actions (see picture) for increasing biodiversity.
- Report or presentation or video, that can be evaluated by teachers following the school’s evaluation grid.



Descriptive labels for species in a grassland (left), seed ball (source: Wikipedia)

Additional reading materials:

- Measuring Biodiversity
<https://www.jove.com/science-education/v/10596/measuring-biodiversity>
- Simpson's Diversity Index <http://www.countrysideinfo.co.uk/simpsons.htm>

Appendix:

- **Worksheet “Key Findings on Biodiversity?”**



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Worksheet “Key Findings on Biodiversity?”

Try to answer the following questions on the basis of the results obtained from the former activities and your personal opinions.

How many species have been found in the site(s)?

What is/are the most abundant species?

Which species are ‘allochthonous’? Which ones are considered invasive?

Which species are most drought resistant?

Which species would you like to see in that place in the future? Why?



Why is biodiversity important for the ecosystem?

How can you increase biodiversity? Design a project plan to increase the biodiversity of the area (think about all the steps: planning, performing, maintaining, monitoring to make a successful project)

