

Ecosystem services

Documentation and inspiration for teachers in Sweden and the Baltic region
from workshops in Norrtälje-Stockholm-Uppsala, Sweden, in September 2015



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Print: 2015

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Preface

Background of the project

This pedagogical handbook is a part of project *Nature schools Network 2013-2015*.

When the *Commission on Education of Union of Baltic Cities (UBC)* held its annual meeting in April 2009 in Tallinn, representatives from different nature schools participated and presented their work. After that it was decided that we should create a formal network of nature schools with the aim to develop new strategies and new material for the pedagogical methods to be used in outdoor and natural sciences teaching in Sweden, Estonia, Lithuania and Latvia.

This network was established and has been funded by Nordplus Horizontal 2010-2012 and the network has accomplished:

- Three courses on the themes:
 - *Outdoor teaching*
 - *Humans and nature, where nature is represented by 3 different biotopes – i) water, ii) forest and iii) acre land*
 - *Pedagogies in teaching climatic effects*

Three pedagogical handbooks (PDF in English at www.farsnanaturcentrum.se)

Outdoor learning
- documentation and inspiration for network
of nature schools in the Baltic region and
Sweden 2010



NORDPLUS
Horizontal

Human and Nature
Nature schools Network 2011



NORDPLUS
Horizontal

Climatic effects
Pedagogies in teaching about climatic effects
Nature school Network 2012



NORDPLUS
Horizontal

- Two class exchanges (Sweden-Estonia)
- One Comenius Regio application (granted for 2011-2013) between Tallinn and Norrtälje Municipality with Nömme Nature House, Erken Laboratory and Norrtälje Nature Conservation Foundation as partners. The aim of the network was to grow by adding partners and increasing collaboration with local enterprises in the field of nature conservation, nature guiding, local organic food production and monitoring of the environment (researchers) as well as teachers. We had partners from teacher training (higher education, Uppsala University), Commission on Education and Environment of UBC, small enterprises and we

collaborated closely with local teachers from secondary and upper secondary schools joining our workshops and seminars.

Purpose

The purpose of the first three years of the last Nordplus project was to establish a network for nature schools in the Baltic region and to create courses and course material (pedagogical handbooks) for teachers in these countries. As the network has been established, visions for the future have also been made. The three main aims for the period (2013-2015) are:

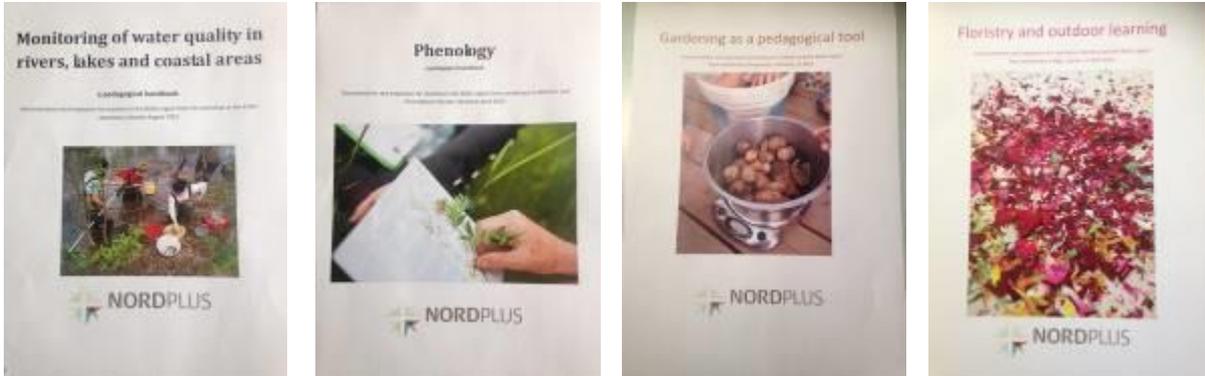
1. To have two 3-day workshops/seminars every year, and to distribute the hosting of the workshops/seminars among the partners. This will enable all partners to contribute more and to make the best use of their most prominent fields of knowledge. This will contribute to high quality workshops raising the capacity of the network to a higher level to be used in all participating countries and to be spread to all members of the Union of the Baltic Cities (UBC) and within the network of the Cost action Netlake (EU).
2. To include small enterprises and researchers in the field of nature conservation, nature guiding, local organic food production and monitoring of the environment in the workshops/seminars together with nature school teachers, local teachers and representatives from higher education of teachers in order to contribute to cooperation between the educational sectors and to establish cross-sectoral networks involving participants outside of the traditional education sectors.
3. To produce and edit handbooks for each workshop/seminar event to be used to spread the pedagogic highlights through the networks mentioned above and via the web site.

Aims and contribution for this new project *Nature Schools Network 2013-2015*

We feel that the aims stated by the Nordplus program, and for all participating partners in this project are in common:

- Increase the exchange of pedagogical ideas and methods related to nature within the Baltic region leading to a higher quality in outdoor educational activities
- Develop an understanding for field education on different levels in the school system from elementary school to university using new input from small enterprises in the field of nature conservation, nature guiding, local organic food production and monitoring of the environment
- Transfer the hands-on knowledge of small enterprises to teachers and educational program in schools and in the university program for teachers

- Be a part of producing pedagogical handbooks during each event and also be able to distribute them in the home country.



Sectors who are involved in the project

- Higher education
- NGO
- Primary/secondary/upper secondary Schools
- Private sector



Färsna farm in Norrtälje. The base for Norrtälje Nature Conservation Foundation, Norrtälje in Sweden.

We really hope that this handbook will inspire teachers to go outside with their students and see the large classroom- the garden, the schoolyard, the nature, the seas, the rivers, different environments and the seasons.

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Ecosystem services

Ecosystem services are the functions of ecosystem that somehow benefit humans. There are services we get for free from nature, such as wild fish and berries, pollinating insects, water, wind, hydro and processes as photosynthesis. Plants, animals and microorganisms works very hard and we need these services to survive. Many of these ecosystem services are impossible to replace with technology. Ecosystem services purify the air, contributing to food and water and protecting biodiversity. They also reduce noise, increase human physical and mental wellbeing, absorb carbon dioxide and give us energy.

A garden and the nature are wonderful places for learning about ecosystem services. With all senses the students learn about nature, seeds, food, beauty, economy and ecosystems- for a sustainable future. The outdoor classroom is perfect places for curiosity, questions and investigation.

Outdoor learning wants to give as many sensory experiences as possible. The sensual experiences create memories for life. We strive to build good self-esteem for the participants and the group will be strong when they work together. Nature, vegetables, flowers, animals, garden and outdoor living is a tool that creates unprecedented opportunities. Go outside together with the students!

Outdoor learning is about learning in authentic environments. A new world opens up, when we leave the indoor environments and also uses the outdoor environments near school. Opportunities to find knowledge today and in the future are staggering. The students must learn inside, outside, in reality, in books, with internet, in companies and so on. Outdoor learning is about learning with all the senses, to touch, see the wholeness and the pupils have to feel that they are a part of the learning process.

We can work with many aims in the curriculum and all subjects when the theme is ecosystem services. Mathematic, biology, chemistry, art, language, music and different handicraft. But the most important thing is that the authentic environments often are the best classrooms for discussions about a sustainable future.

Supporting services

These services assist other processes in nature to operate. They are essential for life. These supporting services include:

Photosynthesis

Soil binding

Nutritional in nature

Water cycle

Habitat for different species

Biodiversity

Provisioning services

Provisioning services are nature's services as we humans direct costly to use and need for survival as food and water. Goods are sold and bought. The provisioning services are:

Drinking water

Fuel

Medicine

Raw material

Regulating services

Regulating services are the nature services that allow nature resist or arrange temporary problems. They protect us from difficulties. The regulating services are:

Control of erosion

Water treatment

Protection against diseases

Protection against pests

Protection against natural disasters

Better climate Cleaning air

Cultural services

Cultural services, it is in nature that makes people happy and gives life meaning. Culture is about the life and well-being. Cultural services are:

Beauty and spiritual values

Recreation and tourism

Nature provides inspiration and knowledge

Health and rest

Inspiring learning environments



Recommendations for leadership outdoors

- Respect any fears in the group.
- Aims and tasks should be clear to the participants.
- The leader is always a good role model for clothes, safety and approach.
- The participant's needs and questions will always be the first step. The leader must be flexible and willing to change plans. Catch the situation and see all possibilities. Take advantage of the seasons and the weather changes to create diverse experiences.
- High level of knowledge about nature, other subjects and outdoor life knowledge gives confidence in the leadership.
- The learning/activity should be adjusted according to season and climate. Lessons, discussion, information and reflection should be in a circle so everyone feels involved. The leader should not speak against the wind and preferably seek shelter for the wind.
- All participants' basic needs should be satisfied - warm, fed, dry and well-rested.
- Activities and games should be inclusive. Cooperation should be encouraged and trained.
- The location of the activity should be carefully chosen and the leader should be familiar with it. With younger children, it is advisable to return to places so that they become confident, which is a prerequisite for learning. For youth new places can be a challenge that inspires to investigative work.
- Prefer to get long lessons to reduce stress and give participants the chance to learn, play, and also have some recreation.
- Safety should always come first in outdoor learning. It is important to be familiar with the plans for accident or disappearance.

Examples and methods

Example 1 *Beehives in the garden*



Aim/purpose

Students will get more knowledge about bee and pollinations as an ecosystem services.

Preparation

Try to learn more about bees and bee hives. Read in books and look at movies.

Material

Beehives

Method

Visit a beekeeper and see bees in reality. This is a good example of a authentic learning environment. Most preferably, have your own hives in the schoolyard. In this way, pupils can observe life in and outside the hives throughout the year.



Reflection

Students learn how stunning the bees are and what the ecosystem services bees do for the nature and us. Their pollination is vital and we also get products like honey and wax from bees.

Example 2 *Brushes for pollination*



Aim/purpose

Enable students to understand how great and vital work of many insects make for pollination of flowers.

Preparationsns

Gathering all materials.

Materials

- Brushes
- Tape
- Plastic
- Scissors
- Black pens for writing at plastic

Method

Draw wings at plastic sheets. Cut them out. Take a black brush and decorate with yellow tape if you want to make a bee.

Attach wings with a thumbtack. Ready!

Reflection

Students can try to pollinate flowers with the brushes. From flower to flower...

What impressive job bees do!



Example 3

Insect hotel



Aim/purpose

By building a hotel for insects the students will learn how to help bees and other aculeata (sv: steklar) to find a suitable place to build a nest.

It is a good exercise linked to discussions about ecosystem services and how pollination works.

Today many of the structures needed for pollen and nectar seeking insects is missing. Blossoming roadsides, field margins, open ditches, dead wood and stone mounds are gone.

Therefore it might be great help building insect hotels in your garden where the bees can find flowers and a good place to live.

A lot of species build their nests in the sand. But for those species that are based in the reeds or decaying tree trunks and branches, an insect hotel can be paradise!

Many of our fruit trees and flowers are pollinated by honey bees and wild bees. In Sweden there are about three hundred species of bees. The wild bees called solitary bees when they live alone, unlike honey bees which are a social bee.

Preparation

A hotel for insects can be made in many different ways. We chose to look for usable things that we already had on our farm that could be reused in an insect hotel. We found old rebar and cut them into usable lengths.

Four rebars were cut into lengths corresponding to the insect hotel's height. Then we cut eight short lengths that would later be attached to stabilize the construction.

We gathered wood and natural materials that are potentially material to attract insects that search place to build a nest.

Material

- Rebars
- Wire
- Firewood
- Dried hollow plants
- Drill
- Different sized tubes
- Skewer

Method



The construction of our insect hotel is very easy. A sketch of the insect hotel is the only instruction needed. Place all material so it can inspire by itself! If you have plenty of time the pupils can collect suitable material themselves.

If you have access to firewood and thicker sticks, you can drill holes in the ends. All holes are opportunities for insects to find a place for rest!

It is very useful to have different sized tubes. The tubes can be filled with small branches and hollow plants.

Start by making holes in the ground with a skewer. One hole for each long rebar. Put them in a shape of a square, a bit narrower than your wood.

Attach the short rebar horizontal to the long ones with wire, to stabilize the construction. Then it is only to start fill your insect hotel with wood, branches, hollow plants, tubes and other material that you got



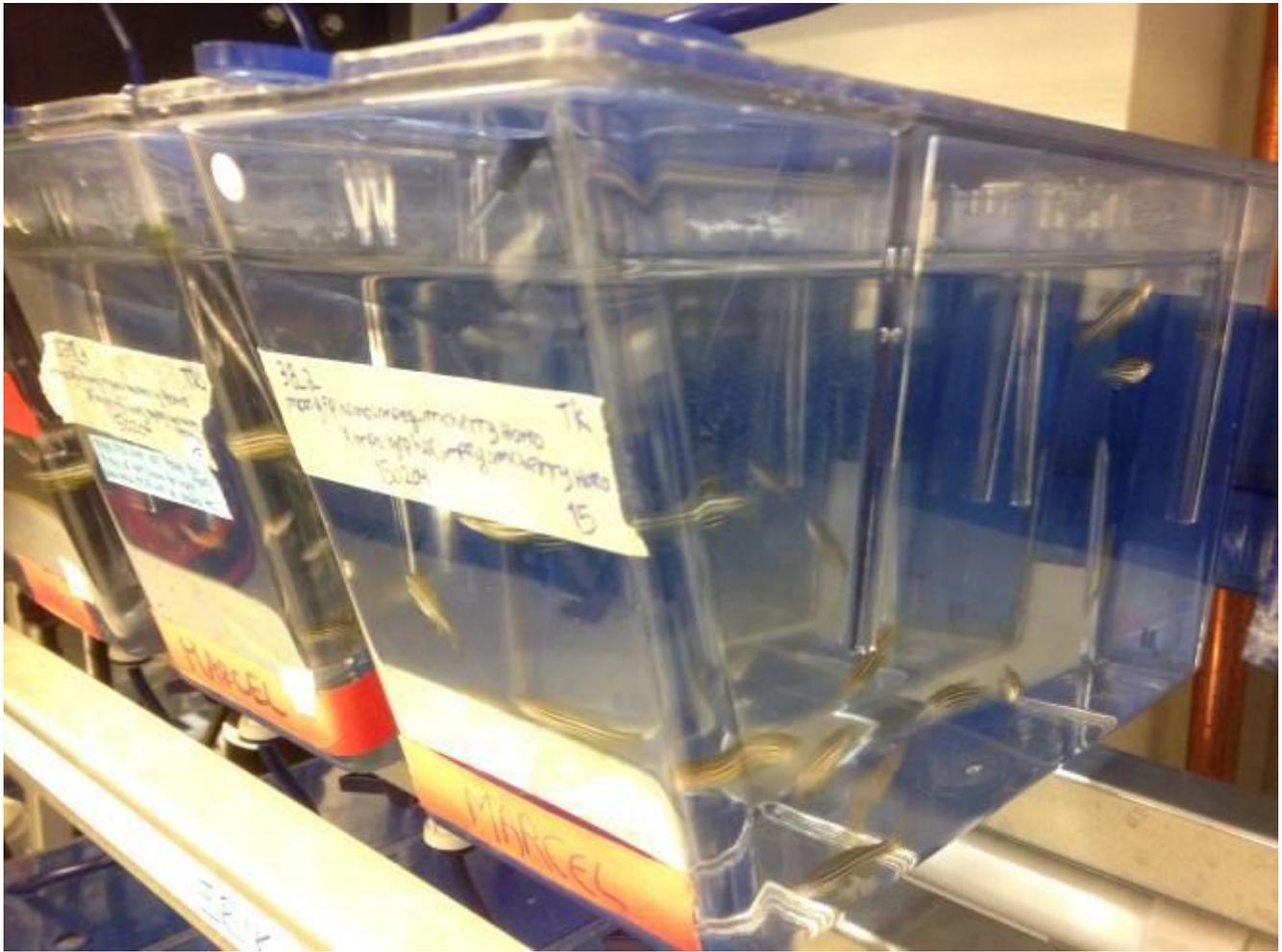
Workshop participants are building a hotel for insects at Färsna farm in the pedagogical garden. September 2015.

Reflection

To build an insect hotel in the school garden (or in other places) is a fantastic way to inspire students to work with biodiversity, ecosystem services and pollination. Combine your insect hotel with an information sign. People who pass by will be curious!

Example 4

Zebra fishes for research



Visit at Zebrafish Technology Platform, SciLifeLab, Uppsala University

Dept of Organismal Biology, Uppsala University

Katarina Holmborn Garpenstrand

SciLifeLab

SciLifeLab is a national center for molecular biosciences with focus on health and environmental research. The national infrastructure is funded through grants from the Swedish government. They offer users:

Facility user- **Keep fish in tanks in tanks in the system use work stations and microscopes.**

Education- **They educates users in methods and protocols, for example how to inject into zebrafish embryo.**

Technique services- **Production of mutant zebrafish lines- In situ hybridization/immunohistochemistry techniques- Light sheet microscopy**

Implementation of new techniques into zebrafish system

Contact:

Katarina.garpenstrand@scilifelab.uu.se

Dept. of Organismal Biology, EBC, Uppsala University

Method

At our visit we investigated the zebra fishes. They grew extremely fast! See the working-sheets at page 20-22.

Reflection

Look around the school, nature school or in the town. Are there any companies who are working with ecosystem services?

Working sheet 1

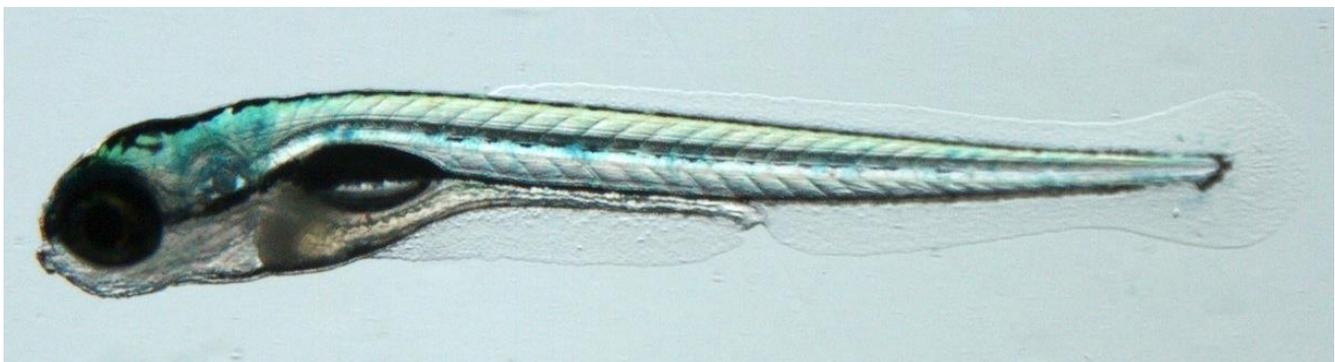
SciLifeLab, Uppsala University

Station 1

You start with a plate containing zebrafish embryos in different stages. Observe the embryos under the microscope. Older embryos will be swimming around and to be able to observe them in greater detail you need to anesthetize them. For this you use MS-222 (Tricaine). Add 1ml Tricaine to one petri dish.

1. Study the different embryo stages. Sort embryos from different stages to a 6-well plate. With the help of the attached pictures estimate how old the different stages are.
2. When can you see the first pigmented cells?
3. Heartbeat: In what stadium can you observe the heart beat?
4. Where and when can you observe blood circulation?
5. Point out organs/structures in the fish?

Mouth muscle eye ear swim bladder Brain



Heart Jaw large blood vessels residual yolk

Working sheet 2

1. Introduction to the aquatic systems where zebrafish is being held.
2. Identify zebrafish females and males. You have got one tank with mixture of females and males. Try to separate the females from males.

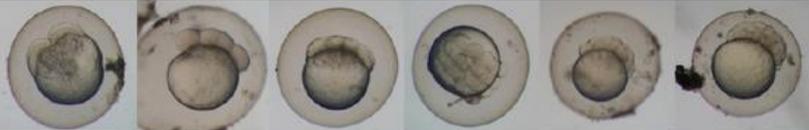
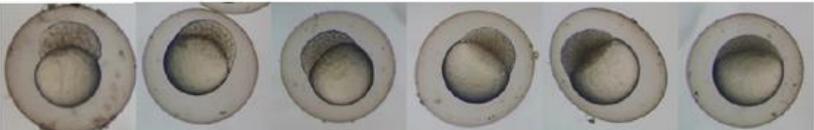
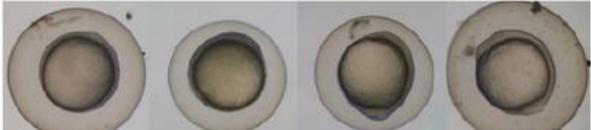
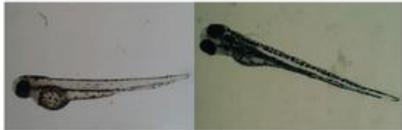


Females:

Larger belly than males. The fins are often yellowish. Abdomen withish.

Males:

Thin and slender. Body often reddish. More pronounced anal fins than females.

Duration	Period Name	Image
0 - 0.75 hrs	Zygote Period	 <p>zygote 1-cell 2-cell</p>
0.75 - 2.25 hrs	Cleavage Period	 <p>4-cell 8-cell 16-cell 16-cell 32-cell 64-cell</p>
2.25 - 5.25 hrs	Blastula Period	 <p>128-cell 256-cell 512-cell 1K-cell 2K-cell oblong</p>
5.25 - 10.33 hrs	Gastrula Period	 <p>80% epiboly 90% epiboly tailbud 2-somite</p>
10.33 - 24 hrs	Segmentation Period	 <p>5-somite 10-somite 12-somite 14-somite 17-somite 18-somite 20-somite</p>
24 - 48 hrs	Pharyngula Period	 <p>prim-5 prim-11</p>
48-72 hrs	Hatching Period	 <p>48-hour 72-hour</p>
72 hrs - 30 Days	Larval Period	

Example 5 *Visit a botanic garden*



The Botanic garden in Uppsala, Sweden

Aim/purpose

Students will learn about biology in practice and many botanical gardens are good examples of biodiversity. Often they promote pollination. Students should learn about different species and their characteristics and how they benefit nature and human.

Method

One idea is that students can explore the garden. Where are there most butterflies, bumblebees and bees? Why?

Reflection

Together with the students you can discuss why we need to have botanical gardens. Why? What responsibility does the human have for nature? What responsibility does human have for endangered species?



Example 6 *Bee in town*



Photos: Bee Urban, Stockholm, Sweden

Bee Urban, Pim Bendt, lecture in Stockholm, 1509329

Bee Urban offers interactive services and living environment in urban areas in the form of beehives, gardens for biodiversity and habitat for pollinating insects and birds.

www.beeurban.se info@beeurban.se www.facebook.se/beeurban

Aim/purpose

Schools and companies have possibility to rent beehives from Bee-Urban, and the staff from Bee-Urban takes care of the bees during the year. This is a way for students coming close to this exciting ecosystem services.

Method



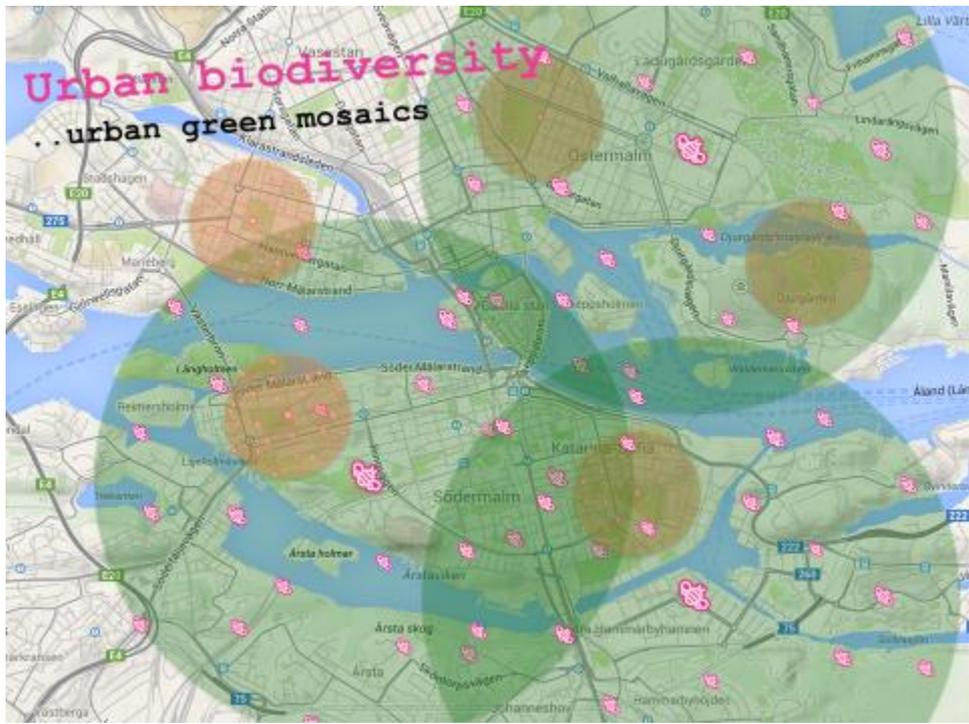
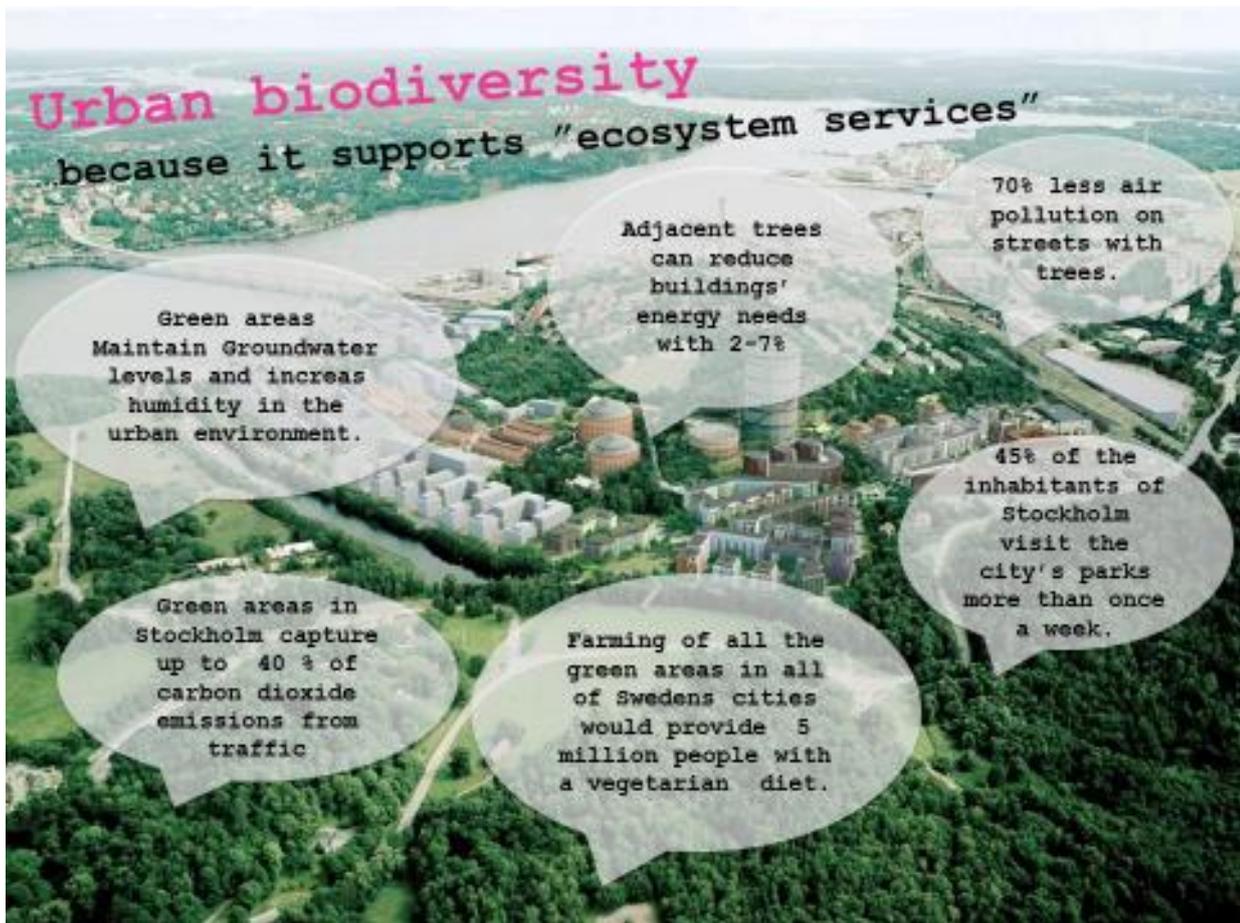
Bee Urban provides interactive environmental services to increase biodiversity in cities.

- Bee hives
- Biodiversity gardens
- Dwellings for birds and insects



How fascinating for students meeting the bees in city and countryside? What happens without pollinators? Why is it more difficult for them surviving? What can humans do for given them a better environment?

Potos: Bee Urban, Stockhol, Sweden



Photos: Bee Urban, Stockholm, Sweden

Example 7 *Vertical garden*



Fantastic vertical garden at a wall in the city of Stockholm!

Aim/purpose

To arouse students' interest in the ecosystem in the cities and how people can benefit different environments for increased diversity.

Method

Go on field trips with students to various places where the municipality, the state or the company taken responsibility for promoting biodiversity. This is an example of a vertical garden in Stockholm, Sweden.

Background

Stockholm City is the owner and client of Björn's Vertical Garden. The background is that Stockholm wants to develop the works with ecosystem services and generate knowledge about vertical greenery. *Butong AB* is the company who have cast the concrete blocks as the plants grow and meander in. If a plant dies, so picked it only removed and new plants spread by roots and take over its place. This means that maintenance costs are minimized. In total, the wall is approximately 40sqm.

Water from the roof is collected in a tank, 1m³, on the terrace. The tank has an evacuation pump connected to a mains timer. Every night at 23:00, then turn the timer on the pump that pushes water out to a drip irrigation hose in the wall side. Excess water disappears into the storm water drain near the wall. Nutrient added to the tank when necessary.



Larvae of bees in the reeds.

Bumblebees have been common in the vertical garden.

Photo: *Butong AB*, Stockholm



High in the wall are two slots in order to take out substrate.

Photo: *Butong AB*, Stockholm

Reflection

This is an excellent way to promote biodiversity in the city. At this wall in Stockholm people were scribbling much before.

Example 8

Bake a cake from apples



Aim/purpose

The students will see what wonderful nature give to us like apples.

Preparation

Pick appels in the garden, or if you find in the forests. Buy ingredients for baking

Material

- Apples
- Cutting board and knives
- Ingredients for baking the cake
- Baking tin
- Oven

Methods

Remove the cores of apples and cut apples into thin slices.
Read through the recipe below and bake together:



Recipe for apple cake

- 100 gram butter
- 3 eggs
- 1,5 deciliter milk
- 2,5 deciliter sugar
- 3,5 deciliter flour
- 2 teaspoons baking powder
- cinnamon
- 6 apples

Melt the butter and let it get cool. Beat eggs and sugar until fluffy. Add milk and butter. Stir flour with baking powder. Pour the butter into the mold. Put down the apple slices tight. Sprinkle with cinnamon.

Bake in oven at 175 degrees Celsius for 30 minutes.
Ready!

Reflection

What can we more use apples for? How can we take care of them for all autumn and winter?

What other fruits, berries and mushrooms are it possible to use for food?

Example 9 *Jam from blueberry*



Aim/purpose

Students should see the resources nature provides and learning take care of our berries and fruits.

Preparation

Buy sugar and bring other material for picking blueberry and then making jam.

Material

- Berries
- Sugar
- Cans
- Saucepan
- Ladle

Methods

Go out picking berries in the woods with the students. It becomes a sensual experience of the ecosystem. When the baskets are full return back. Then make a fire and cook the blueberries with the sugar in a saucepan.

Clean jars thoroughly with boiling water. When the berries have cooked about 10 minutes pour the jam into jars. Let the students write and draw labels

Reflection

This is an important knowledge and experience for students today. It will also provide an in-depth knowledge of the forest ecosystem.

Then it's time for reflection together with the students. Are there other species of berries and fruits in the local environment that it's possible using for jam, food and lemonade? Further reflection may be about the benefits of locally produced food.



Example 10 *Photosynthesis- ecosystem services for life*



In a jar with a tight-fitting lid, you can get a plant to survive for years. A good example of nature's capacity to be self-sufficient and renewable.

Sensual ways to make photosynthesis!

Aim/purpose

Working with ecosystem allows students to reflect on the nature variety and wholeness-ecology.

Preparation

Select a suitable natural or an available garden.

Material

- shovels

- tape
- transparent jars with lid
- water

Method

Let the students discover the ecosystem in pairs or small groups. Let them choose a small arbitrary area to investigate. A good way is to get a grip on the ecosystem is that they think in different layers. Allow pupils need to use all their senses and equipment like magnifiers.

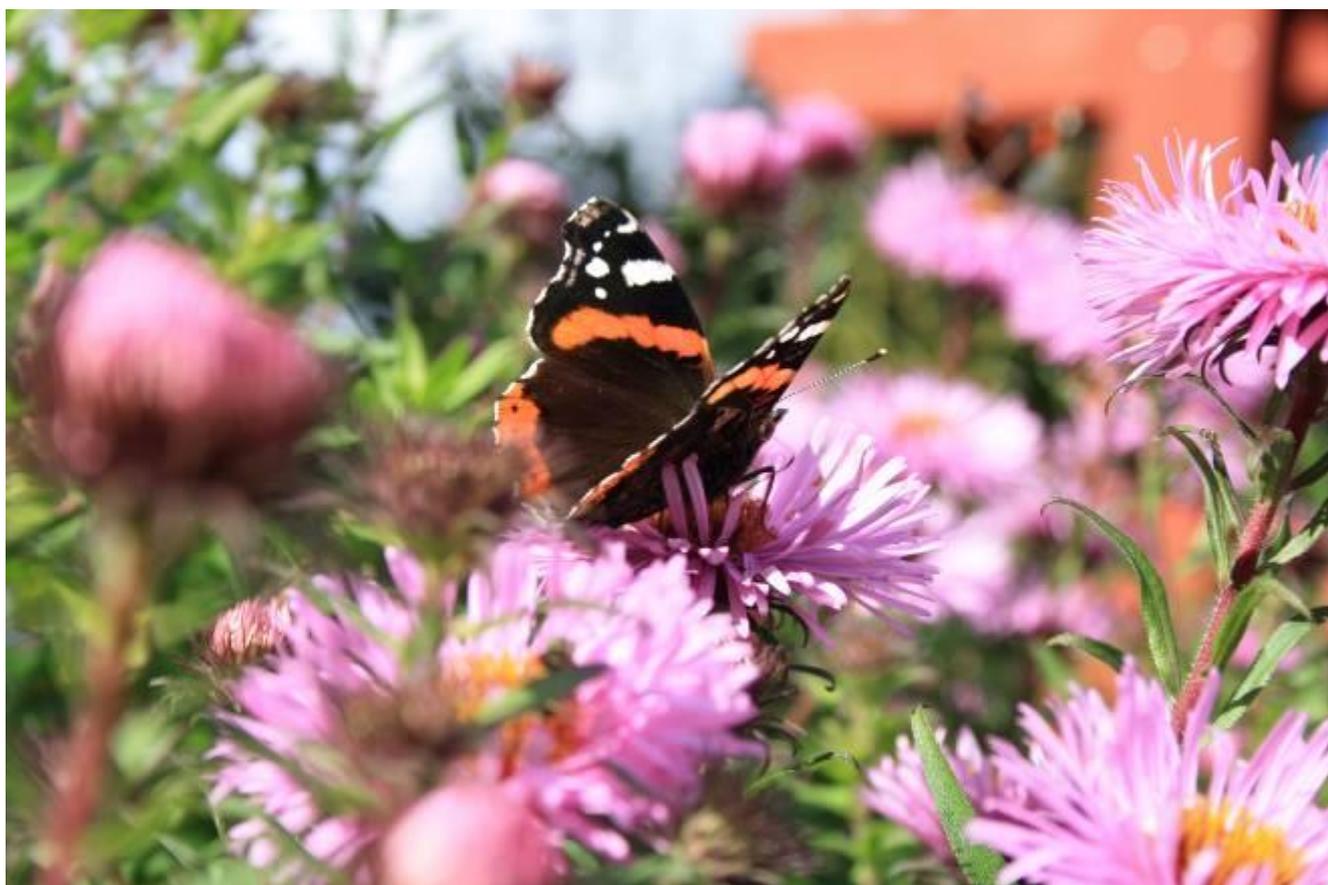
Talk about the ecosystem and what is needed for the ecosystem to be self-sufficient so you can come up with how to build their own ecosystem. Build ecosystem in a jar with tight-fitting lid. Start with some drainage material in the bottom of the jar, for example stones. Continue with a seedling of what you will find, as you dig up the root balls and everything. It works well with moss, wild strawberry plant or a small tree.

When the students are satisfied it is time for a discussion if they need more water. The idea is that there will be a small loop of water, oxygen/carbon dioxide and nutrients to ensure that the plants will survives

Reflection

What different ecosystem services can we see in the jar? How does it work? What happen if we destroy parts of different ecosystems?





*Beautiful ecosystem services
in the garden at Färsna farm, Norrtälje, Sweden*

Partners in the project



Activity 5 in Norrtälje- Uppsala- Stockholm, Sweden 29-30 of September 2015.

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Type of institution: Foundation

Unit coordinating institution

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– An amazing world!



Uppsala University, Erken Laboratory, Sweden



Norrtälje Nature Conservation Foundation, Sweden



Riga Nature School, Latvia



Pärnu Nature House, Estonia



Nõmme Nature House, Estonia



Nature School of Panevezys, Lithuania