Monitoring of water quality in rivers, lakes and coastal areas

a pedagogical handbook

documentation and inspiration for teachers in the Baltic region from the workshop at the Erken Laboratory, Sweden August 2013

NORDPLUS

Project name: Nature school network

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Preface

Background of the project

This pedagogical handbook is a part of Nordplus 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)

- 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 network aims were 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 had collaborate 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 following 2,5 year (2013-2015) period 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 2013-2015

We feel that the aims stated by the Nordplus programme, 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

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

• Transfer the hands-on knowledge of small enterprises to teachers and educational programmes in schools and in the university programmes for teachers

Sectors who are involved in the project

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

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We really hope that this handbook will inspire teachers to go outside with their pupils and see the big classroom- the nature, the seas, the lakes, the garden, the rivers and different environments.

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Inspiring learning environments

Examples and methods

Example 1 *Plankton*; Teacher's Guide

Aim/purpose

Students will learn about the larger forms of planktonic life in your local lake, pond, or other water body by collecting samples to examine in the classroom or laboratory. Although plankton are usually sampled on open water, you can sample from shore if you are unable to arrange boat access. By looking at the composition of plankton and how it varies by season, the pupils learn about species diversity, life history traits (as some plankton such as larval forms of crustaceans are only planktonic during early stages in their development), and food web interactions. You can work with educational goals in:

- *Mathematics, ecology, food web interactions and seasonal changes.*

Preparations

If possible, arrange for boat access to the lake or pond to facilitate sample collection from open water. Safety measures such as providing life vests must be planned in advance. Ideally, we would like to return to the same site repeatedly through the growing season from spring through autumn. The best situation is to find the same depths in our lakes and take water from the whole water column in the photic zone (estimate the photic zone depth by multiplying Secchi depth x 2).

Divide the pupils into groups that will be responsible for investigating the plankton samples. Introduce the pupils to the sampling equipment and microscopy.

Materials

- Water sampler
- Secchi disk (to determine depth of the photic zone)
- Bucket or container for mixing samples to make a “composite” sample (optional)
- Plankton nets (mesh sizes for larger phytoplankton range from 20 to 64 µm, and for zooplankton range from 64 to 200 µm)
- Plankton bottles
- Lugol’s solution (for sample preservation)
- Camera or telephone
- Simple keys or books for plankton identification

Methods

Travel to the predetermined sampling point in the lake or pond. Use the sampling equipment to collect water samples for plankton analysis. If you are collecting from several depths, use the bucket to mix samples and take a subsample of this mixed “composite” sample for study. Be sure to stir the sample before pouring into a plankton net. (Remember to keep the valve at the bottom or “cod end” of the net closed so the concentrated plankton sample is captured in the cup.) If you choose to create a composite sample, note the total sample volume that was collected so results can be expressed in number of organisms per liter. Alternatively, collect directly from the net after towing the net through the water. Add Lugol’s solution if samples will be held more than 24 hours before

analysis. You should add enough Lugol's to have a 1% concentration of the preservative in the sample, so if, for example, you collect 100 mL for classroom study, you will need to add 1 mL Lugol's solution. If you use smaller bottles, adjust the amount according to your total sample volume to be preserved. You may want to save preserved samples for future examination, so it is important to carefully label your samples. Be sure to label your sample bottles clearly with the date, time, location, and sample depth(s). During your class lab session you will need time to look at your water samples and identify what you see through the microscope. Record your data carefully so you can make comparisons with results from different times of the year and another idea is to post the result on-line to compare your findings with other schools or classes. By repeating this sampling during the spring season, you can see the changes in composition of phytoplankton and zooplankton.

Reflection

Encourage your students to use their journals to record their observations. Challenge them to evaluate their results. Pose questions to get them to reflect on their experiences. Encourage collaboration and suggest that students exchange field notes with others to seek peer review, or in your own review, select some examples to commend in front of the class to recognize insightful and creative work. Just a reminder: the phytoplankton your class collects are likely to represent the status of the community if you collect from the photic zone but the number of zooplankton captured in a sample is a reflection of several factors including the quantity and quality of the food sources available, time of day, and sampling technique.

Supplemental activities

- Construct your own plankton sieves to fractionate bulk water samples by size (see: http://www.cosee-ne.net/resources/planktonsieve.php)
- Phytoplankton include several groups of algae and the cyanobacteria. Although cyanobacteria are sometimes called "blue-green algae" they are actually a group of photosynthetic bacteria rather than eukaryotic algae. Pursuing a more complete study of algal classification provides the opportunity to point out structural differences among the phytoplankton you encounter. For example, drawing your students' attention to the fact that prokaryotic cyanobacteria do not have a membrane-bound nucleus or plastids to contain their pigments like their algal counterparts, is a feature you can use in teaching cell biology. Additionally, covering the basics such as identifying the six divisions of eukaryotic algae typically found in lakes and other inland waters (Chlorophyta; Euglenophyta; Bacillariophyta; Chrysophyta; and Pyrophyta) is a basic building block for understanding biological diversity.

- Spend some time emphasizing the importance of phytoplankton as foundational members of aquatic food webs and as key players in the global carbon cycle through their photosynthetic fixation of carbon dioxide and release of oxygen as a by-product.
- Zooplankton: Ask your students to explore the literature on where the species of plankton they find fit into the lake's food chain. It might look something like this:
  Phytoplankton → zooplankton → predatory zooplankton → filter feeders → predatory fish

References and Resources

Websites

www.freshwaterecology.info - To find out what is found in your region, this database contains information on more than 12.000 European freshwater organisms including fish, macroinvertebrates, macrophytes, diatoms and phytoplankton. (source: Schmidt-Kloiber A. & Hering D. (eds.) (2012): www.freshwaterecology.info - the taxa and autecology database for freshwater organisms, version 5.0 (accessed on 21/8/2013)

(additional options with specific phyto- and zoo-plankton information)

Books

Kalff, J (2001) *Limnology.* Prentice Hall, New Jersey, 592 pp.

Written from an ecosystem perspective, this book discusses "events that happen below the waterline of lakes, rivers, and wetlands and links them back to the attributes of the drainage basins...." A new edition of this book is expected in 2014, and it may be available electronically.

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Student's guide: Plankton

Aim/purpose

Plankton are free-floating organisms that are carried by water currents. There are three main groups of plankton: the phytoplankton, which are plant-like and are considered "primary producers" because they can make their own food; the zooplankton, which are animal-like and "consumers" of other plankton; and the bacterioplankton, which include free-floating bacteria and Archea that are "decomposers" that break down the wastes from other plants and animals and recycle nutrients. All plankton groups are important parts of aquatic food chains. We will focus on the larger members of the phytoplankton and zooplankton communities because they are easier to see (although not too easy!). In this study, your job is to characterize the plankton in a water body and look at changes over time. The key steps you will undertake include:

- Investigating what phytoplankton and zooplankton live in your lake (or other water source) by identifying and counting organisms
- Documenting seasonal changes
- Comparing your water body to those studied by other BaNRI classes

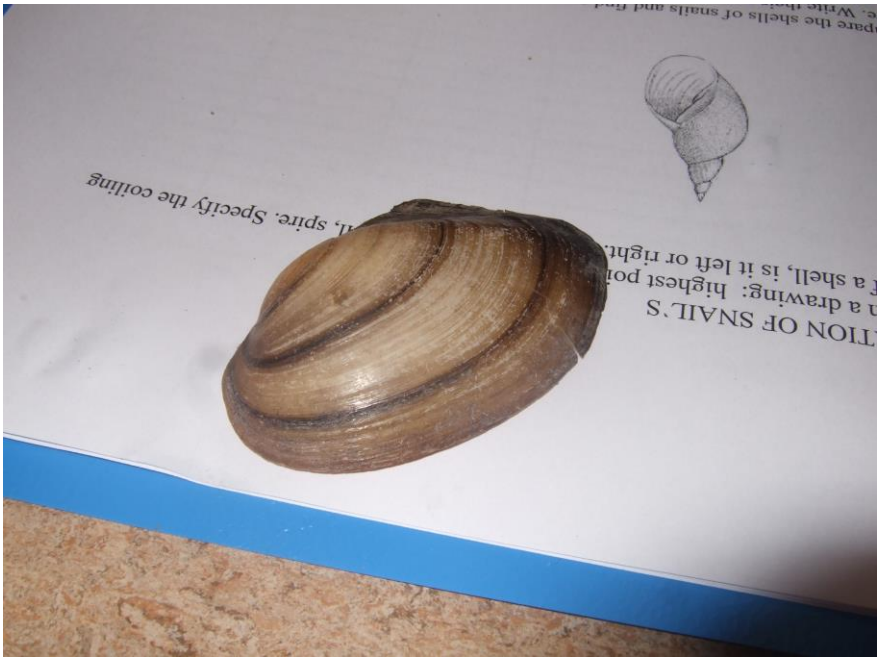
Preparations

Plankton are sampled mostly in open water, but if you do not have access to a lake by boat, you can still collect from the shore. Ideally, you will make a composite or mixed sample from the water column by using a water sampler and plankton net. It is also possible to take samples close to the shore by filtering water through a plankton net along the water's surface. Your teacher(s) will guide you in selecting a sampling point.

You should become familiar with the equipment you will use in the field and the microscope you will use in the classroom before sampling. Depending on which nets are available, you may be divided into groups that will focus on either phytoplankton or zooplankton collection.

The species of plankton that you collect from your sampling excursion will depend on the depth and location of your sample and the mesh size of your plankton net.

Example 2 *Running water*; Teachers guide



Aim/purpose

Streams are sometimes easier to reach than lakes and there is no need to use a boat for sampling. The pupils learn to investigate how the flora and fauna differs between our streams, how to collect animals and determine species. You can work with educational goals in:

- *Evolution, pollution, ecological status, seasonal changes.*

Preparations

Start by choosing a stream that is reachable for you and your pupils. It should be easy to reach and possible for the pupils to investigate (not to deep or steep). Also make sure that the site comparable to the other sites investigated by the other schools.

Divide the pupils into groups that will be responsible for different parts of the investigation:

1. Collecting bugs
2. Collecting plants
3. Measuring temperature, stream velocity and color of water
4. Describing the surrounding area and taking photographs

If you wish, you can duplicate the groups (especially the one collecting bugs). Introduce the material to the pupils and make sure that each group is responsible for their own equipment.

Material

- Strainers
- Small plastic jars
- Big plastic jar
- Rubber boots and/or waders
- Thermometer
- An orange
- Measuring tape
- Timer
- Plastic glasses and a white paper
- Camera or telephone
- Simple keys or books for determining species of bugs and plants
- Field journals

Method

Each group will collect material according to their field journal. They use the equipment they have been provided with and fill out the information in their lists. This will then be used back in the classroom, where you can make comparisons with results from different times of the year and also post the result on-line, so that the pupils also compare with the other schools.

Reflection

By using a notebook, the pupils should note some short sentences about what they have learned from the investigations. What does the result tell them? How can they be used? What could the pupils do to improve the status of the selected littoral?

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Student's Guide: Running water

Aim/purpose

Streams represent important habitats and resources for plants and animals. The condition of a stream (polluted or unpolluted) is reflected in the life it contains. Your job is to investigate a local stream to discover the life it supports in your community. The key steps you will undertake include:

- Exploring the flora and fauna by identifying and counting by species or taxonomic order
- Documenting seasonal changes in the stream and different flow events
- Comparing your stream with other streams studied by BaNRI classes

Preparations

Your class will be divided into four groups to investigate your stream. Each group will prepare the results to share with the class and form a complete picture as a team:

1. Collecting bugs
2. Collecting plants
3. Measuring stream temperature, velocity, and water color
4. Describing the surrounding area and taking photographs (site description)

Your teacher may decide to duplicate groups, if time permits. Each visit to the stream captures a different picture of the stream's function and the changes it experiences over time. Some changes may be in response to natural events such as storms, while others may be in response to human activities both upstream and near the stream's banks.

Materials

Strainers
Small plastic jars
Big plastic jar
Rubber boots and/or waders
Thermometer
An orange
Measuring tape
Timer
Plastic glasses and a white paper
Camera or telephone

Example 3 *Benthic fauna*; Teachers guide

Aim/purpose

The aim of investigating the Benthic fauna of our lakes, is to estimate the ecological status of our lakes in a simple way. At the same time, the pupils learn how to collect animals, determine species and using simple mathematical methods. You can work with educational goals in:

Mathematics, pollution, ecological status and animal adaptation.

Preparations

Start by seeing if there are boats in the area that could be used, and if there is a map shoving the different depths. The best is if we could try to find the same depths in our lakes.

Divide the pupils into groups that will be responsible for investigating the different depths.

1. 1 m
2. 5 m
3. 10 m
4. 15 m
5. 20 m

Introduce the pupils to the equipment and the field journals.

Material

- Ekman grabber
- Large strainer
- White plastic jar
- Secchi disc
- Camera or telephone
- Simple keys or books for determining species of bugs and plants
- Field journals

Method

Each group will travel to a spot that has the depth they are going to investigate. They use the equipment they have been provided with and fill out the information in their lists. This will then be used back in the classroom, where you can make comparisons with results from different times of the year and also post the result on-line, so that the pupils also compare with the other schools.

One way to compare the ecological status is to divide the number of Chironomids with the number of Tubifex – the higher the quote, the better the status. Tubifex is the most tolerant benthic specie and if the water quality is very poor, they will be very abundant.

Reflection

By using a notebook, the pupils should note some short sentences about what they have learned from the investigations. What does the result tell them? How can they be used? What could the pupils do to improve the status of the water in the area?

Example 4 *Littoral*; Teachers guide

Aim/purpose

The aim of investigating the littoral zones of our lakes, is to investigate how the flora and fauna differs between our lakes. At the same time, the pupils learn how to collect animals and determine species. You can work with educational goals in:

Evolution, pollution, ecological status, seasonal changes.

Preparations

Start by choosing an area that is reachable for you and your pupils. It should be easy to reach and possible for the pupils to investigate (not to deep or steep). Also make sure that the site comparable to the other sites investigated by the other schools (we will use wind exposed littorals with a rocky bottom).

Divide the pupils into groups that will be responsible for different parts of the investigation:

1. Collecting bugs
2. Collecting plants
3. Measuring temperature, vision depth and color of water
4. Describing the surrounding area and taking photographs

If you wish, you can duplicate the groups (especially the one collecting bugs). Introduce the material to the pupils and make sure that each group is responsible for their own equipment.

Material

- Strainers
- Small plastic jars
- Big plastic jar
- Rubber boots and/or waders
- Thermometer
- Secchi disc
- Plastic glasses and a white paper
- Camera or telephone
- Simple keys or books for determining species of bugs and plants
- Field journals

Method

Each group will collect material according to their field journal. They use the equipment they have been provided with and fill out the information in their lists. This will then be used back in the classroom, where you can make comparisons with results from different times of the year and also post the result on-line, so that the pupils also compare with the other schools.

Reflection

By using a notebook, the pupils should note some short sentences about what they have learned from the investigations. What does the result tell them? How can they be used? What could the pupils do to improve the status of the selected littoral?

Group 1; Bug collectors

Names:

Place:

Weather:

Date and time:

Animal	Number	Notes

Group 2; Plant collectors

Names:

Place:

Weather:

Date and time:

Plant	Abundance	Notes

Group 3; Temperature, stream velocity and color of water-investigators

Names:

Place:

Weather:

Date and time:

Temperature:

Stream velocity:

Color of water:

(please attach photograph of water against white background)

Group 4; Surroundings and photographs

Name:

Place:

Weather:

Date and time:

Surroundings percentage:

a.) Forest
b.) City
c.) Industry
d.) Farms
e.) Other (please specify)

Photographs:

Literature

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