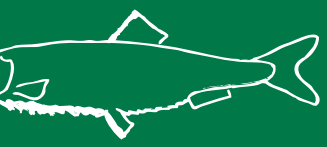
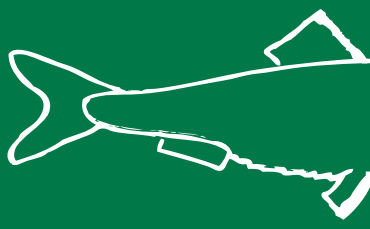
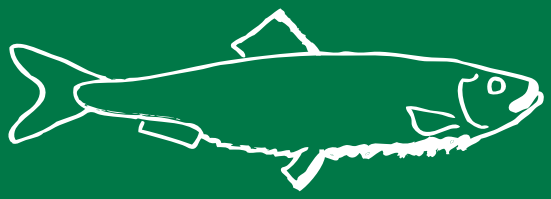
Interactive Supplement III



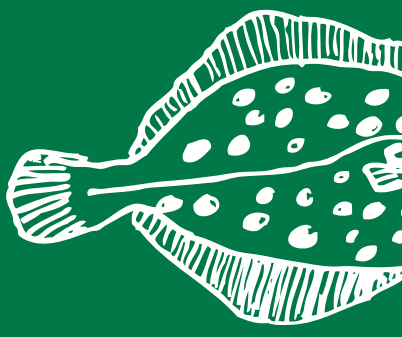
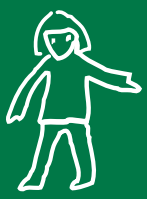



Lab exercises to the theme of the Baltic Sea

Annelie Ehlvest, Külli Kalamees–Pani



Tartu Environmental Education Centre
2011

Interactive Supplement III

Lab exercises to the theme of the Baltic Sea

Annelie Ehlvest , Külli Kalamees-Pani

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This educational material including all appendices may be downloaded and printed from the COBWEB project website www.hyria.fi/COBWEB and Tartu Environmental Education Centre website www.teec.ee.

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This publication reflects the views of its authors.

Text: Annelie Ehlvest
Ideas, worksheets, learning centres: Annelie Ehlvest, Külli Kalamees-Pani
Figures: Epp Margna, Annelie Ehlvest
Photos: Annelie Ehlvest, Helle Kont
Translated by Scriba Translation Agency
Layout: Kaspar Ehlvest

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INVESTING IN YOUR FUTURE

CENTRAL BALTIC
INTERREG IV A
PROGRAMME
2007–2013

COBWEB

KIK
ENVIRONMENTAL INVESTMENT CENTRE

Tartu Environmental Education Centre

Contents

1. Foreword

Discovering the uniqueness of the Baltic Sea

This educational material introduces an interactive study program to study and teach Baltic Sea related topics which has been offered by the instructors of the Tartu Environmental Education Centre to 5th to 12th graders for as long as ten years.

During these years, the practical tasks targeting various topics of the program have been repeatedly supplemented, updated and adapted to reflect the new trends in the environmental challenges of the Baltic Sea as well as the changes in its fauna, usage and protection measures. The comments of both the pupils and teachers which evolved in the course of work were given due consideration in introducing supplements.

However, the general structure and principles of the program have remained as before, relying on the methods of active group work, experiments, evaluations, measurements, discussions and conclusion drawing.

As this form of learning has been kindly appreciated by both the pupils and the teachers alike on and again, we are giving a more detailed overview of the structure, preparations for, materials and implementation of the program.

If desired – where resources are available and there is time and initiative to procure the materials needed – this material can be used to prepare and implement a similar study module in schools, nature centres, etc.

The depicted exercises can also be used in regular classes as illustrative additional exercises or as a source of inspiration to prepare your own new and interesting exercises. However, the material is also suitable for teachers to explore in advance wherever there is a desire to order the program for your pupils.

This educational material including all appendices may be downloaded and printed from the COBWEB project website www.hyria.fi/COBWEB and Tartu Environmental Education Centre website www.teec.ee.

— Annelie Ehlvest

2. Description of the Baltic Sea program

Each learning centre is equipped with materials, worksheets and additional materials

This program is intended first and foremost for 6th to 9th graders as it relates to several subjects and thematic areas of the comprehensive school curriculum, though it can be tackled by younger pupils and is suitable for the secondary school level too.

The exercises are divided by topics onto separate desks or learning centres. Each desk holds the necessary materials, a folder for additional materials and a worksheet with the exercises of these particular learning centres.

The pupils work in small three- or four-member groups who move from one workstation to another. Depending on the age of the pupils and prior group work experience it takes between 2.5 and 3 hours to cover all the learning centres and explore the entire program (if the time is limited, less topics might be chosen). Those classes, who have already addressed the topic of the Baltic Sea and the program is used to consolidate and recap the material, usually work quicker than those who use the program as an introduction to the topic of the Baltic Sea.

The previously mentioned timeframe also includes the supervisor's lead-in at the beginning (10–15 min) and conclusions (10–15 min). In the lead-in the supervisor outlines the workings and structure, the topics of the learning centres and gives advice on how to streamline work. The substantial conclusions at the end of the program may be in a different form, however, it might include a short summary of the topics covered, comparison of some of the results, and reiteration of the key points; also the students might present their own conclusions.

The role of the supervisor(s) is to observe the course of work and, where necessary, help the pupils in their workstations and also, where relevant, ask leading questions or give explanations and encourage discussion. The supervisor's tasks also include the preparation of the lab room for group work, setting out the materials in the learning centres (about 40 minutes), also tidying and packing the materials after completion of the program (about 40 minutes).

The initial procuring and assembly of program materials takes the most time and thus, once the program has been prepared, it makes sense to use it repeatedly.

For some learning centres, access to water is needed to perform experiments and wash the materials and hands. The faucet should be in the lab room or some ancillary room.

This education material describes a total of nine different learning centres; timewise the 'Oil

pollution in water' and 'Salinity' are a bit longer, thus you might want to set up two workstations for these topics to avoid lines gathering at learning centres and so as to not interrupt the workflow.

The following descriptions of the learning centres include three parts: materials and instructions for preparation, printable additional materials and worksheets.

Materials and instructions

A list of required materials, the preparation required to assemble them and recommendations on how to procure/replace the materials is provided for the materials and instructions of each learning centre. A number of materials may be replaced instead of those recommended by us with alternative, more readily available or better suited materials. The more natural objects (shells of bivalves, barnacle shells, fish from the market, etc.) can be used, the better. The materials also cite the additional materials for each topic, which can be printed. The materials also list recommended books, journals, posters, etc., which may be used but can be done without.

Several worksheets require as the final (asterisk-marked) exercise to watch a video clip on computer. Such an exercise is feasible if the room can be equipped with an Internet-connected computer with small loudspeakers. The recommended viewing is the one-minute Baltic Sea themed clips See the Sea (Märka merd) which can be found at HYPERLINK "http://visitbalticsea.net/films/en" http://visitbalticsea.net/films/en (developed within the LIFE Nature project 'Marine Protected Areas in the Eastern Baltic Sea'). Where Internet is not available, you might want to purchase the DVD "See the Sea" published within the framework of the same project. The computer-equipped desk may be used by all of the groups to conclude their work on various topics.

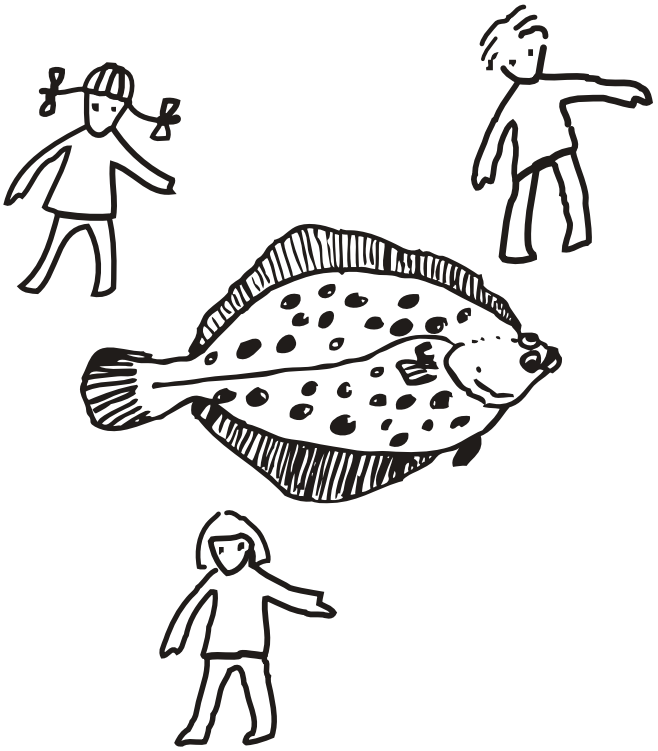
Additional materials

The additional materials of this program need to be printed out during assembly of the program materials. They relate directly to the exercises of the worksheet and cover simple shortened field guides, simple graphs and brief texts on the topic which help solving the worksheet exercises. You may want to gather all the additional materials of a learning centre in a ring binder (with or without clear punched pockets) or a folder so that they become one whole easy-to-use package. The printouts are reusable.

Worksheets

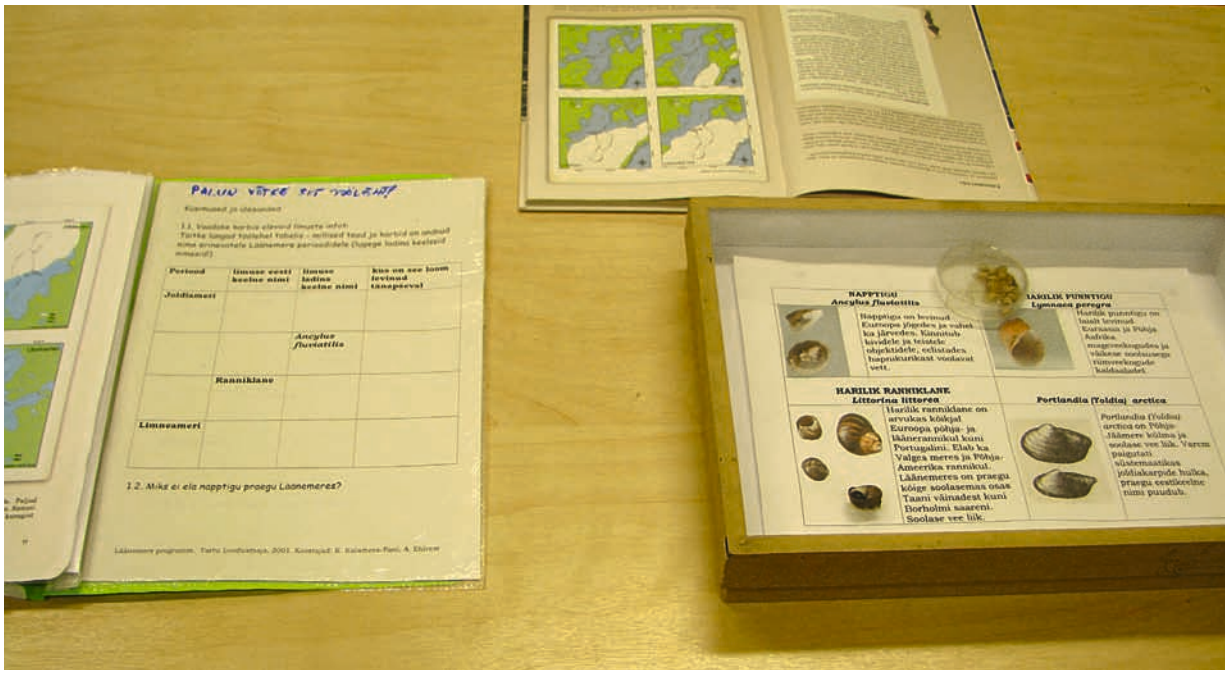
Worksheets cover both thematic exercises as well as instructions, with spaces left in them which are to be filled in with the solutions to the exercises. Worksheets should be copied to match the number of the groups participating. In each workstation, one worksheet shall be filled in per group (2–4 pupils), except when making a poster. The completed worksheets remain with the pupils and will be used for grading or discussions, as required and agreed. The worksheets have been prepared so that irrespective of the presence of previous knowledge, answers and solutions can be reached using the materials and additional materials laid out in the learning centre.

3. Thematic learning centres



3.1. Development stages of the Baltic Sea

Materials and instructions



1. Additional material No 1 (p 9) to 'Development stages of the Baltic Sea' 'Molluscs that live or have lived in the Baltic Sea'

This additional material can be printed out from the next page. The printout may be bound with the other additional materials into a ring binder or placed at the bottom of a glass display box and add samples of the empty shells of the species you can procure/find (see picture).

2. Additional material No 2 to 'Development stages of the Baltic Sea' Development stages of the Baltic Sea

In order to print, download the material 'See the Sea: Unique assets we share', pp. 10–11, from the Internet at www.visitbalticsea.net/download/Book_EN.pdf. The printed descriptions and maps of the development stages of the Baltic Sea should be put in the ring binder or the folder of the relevant learning centre.

3. Copies of the worksheet 'Development stages of the Baltic Sea' may be placed in the pocket of a ring binder so they are easily available when needed. Each group should have printouts of the worksheets.

4. Samples of empty mollusc shells for the species which can be procured/found.
The shells of the wandering snail are the easiest to find because they are abundant in freshwater bays and also in material washed ashore on beaches; it is also very common in freshwater bodies. Finding the shells of other species is more complicated. Empty shells of the river limpet are rather fragile and small, and hard to detect on the shore. Live river limpets may be found in freshwater where they attach themselves to stones or pieces of wood. The shells of common periwinkle may be found in the saltier parts of the Baltic Sea (Denmark, Sweden).

The shells may be displayed either in a magnifying box, Petri dish or simply in a box.

Additional material no. 1

Molluscs that live or have lived in the baltic Sea

River limpet
Ancylus fluviatilis

River limpet is common in European rivers, sometimes also in lakes. Attaches to stones and other objects, prefers oxygen-rich flowing water.

Wandering snail
Lymnaea peregra

Wandering snail is very common in Eurasian and North-African freshwater bodies and shores of low salinity brackish waters.

Common periwinkle
Littorina littorea

Common periwinkle is very common everywhere on the European coasts up to Portugal. Inhabits also the White Sea and the North-American coast. In the Baltic Sea currently the saltiest part is from the Belts to Borholm island. A saltwater species.

Portlandia (Yoldia) arctica

Portlandia (Yoldia) arctica currently inhabits the cold and salty waters of the Arctic Ocean.

Date: Members of the work group:

1. Use the additional materials to look up information about some of the molluscs that live and have lived in the Baltic Sea, as well as the overview about the development stages of the Baltic Sea.

2. Complete the table using the additional materials.
Tip: a majority of the development stages of the Baltic Sea have been named after the Latin names of molluscs.

Development stages of the Baltic Sea	Name of mollusc in English	Name of mollusc in Latin	Where is the animal common nowadays?
Yoldia Sea			
		Ancylus fluviatilis	
	Periwinkle		
Limnea Sea			

3. Why doesn't river limpet currently inhabit the Baltic Sea?_____

_____

4. Why is the Baltic Sea no longer a suitable living place for the bivalve *Portlandia arctica*?

_____

5. Which peculiarity in the construction of the bivalves allows using them, thousands of years after their becoming extinct, to describe the conditions of life in the then seas?

_____

3.2. Salinity and fauna of the Baltic Sea

Materials and instructions

1. 'Salinity and fauna of the Baltic Sea', additional materials No. 1, 2 and 3 (respectively p. 12-13) One-sided printouts, may be laminated if so desired, to be placed in the ring binder or in the folder of this learning centre.

2. 'Salinity and fauna of the Baltic Sea', additional material No. 4 (p. ...). To be printed out, the species of the food chain to be cut out following the cutting line of the tabs and to be set aside in the workstation in a (preferably transparent) envelope or a box, and to be labelled as: *Who eats whom?*

3. Empty shells or remains of at least five animals from among the invertebrates listed in additional material No. 1. Shells can be gathered from the shore. The shells should be placed, numbered and secured, into a glass display box, magnifying cups, Petri dishes or into any suitably sized easy-to-open box(es), or displayed by any other convenient method. These objects are needed to solve the first task in the worksheet.

4. Three saltwater samples marked as A, B and C. In making saltwater samples, use sea salt per one litre of water as follows:
   sample **'Gulf of Finland' – half a teaspoonful** (about 3 g),
   sample **'Denmark Strait' – four teaspoonful** (about 20 g),
   sample **'Western coast of Saaremaa, Lõuka bay'** – one heaped teaspoonful (about 7 g).

5. Small disposable cups or plastic spoons for tasting.

6. A fresh, dried, preserved in spirits or frozen aquatic sowbug on a Petri dish. Aquatic sowbugs can often be found in the bycatch of the Baltic herring. You may ask for them from the sellers at the fish market as our experience is that they are quite happy to pick them out from the crates for study purposes.

7. Copied worksheets for all work groups.

8. In addition, there may be posters of marine invertebrates, field guides and other materials related to the topic. If you can get shells from small mussels that lived in low-saline water as well as from larger mussels reared in saltier waters, you may also display them to illustrate the third task.

9. A computer for the final additional task to watch the clips from 'See the sea' either over the Internet or from a DVD.

Additional material no. 1

A picture guide to the invertebrates of the Baltic Sea

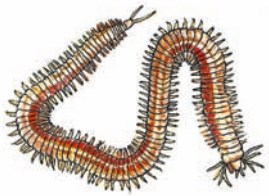
Baltic macoma
Macoma baltica

Common cockle
Cardium sp

Sand gaper
Mya arenaria

Brittle star
Ophiura sp.

Ragworm
Hediste diversicolor



Aquatic sowbug
Saduria entomon

Common starfish
Asterias rubens

Bay barnacle
Balanus improvisus

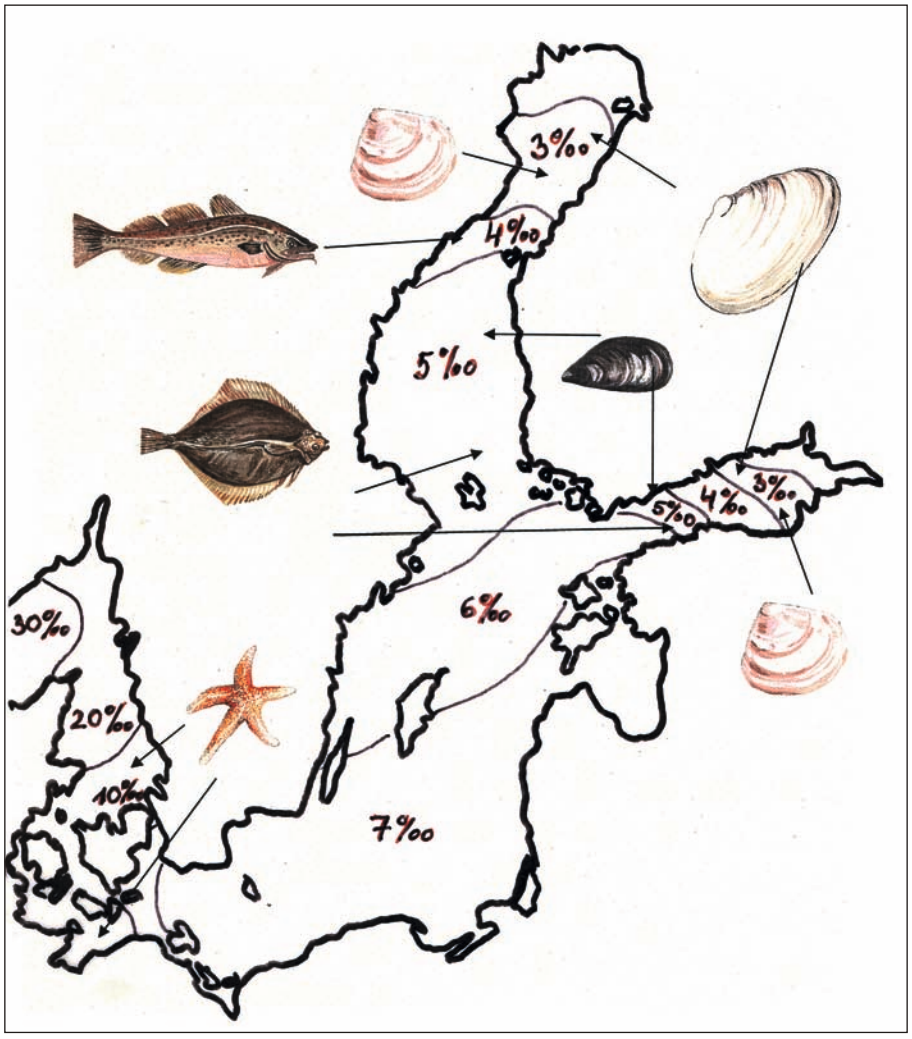
Balti lehtsarv
Idotea baltica

Blue mussel
Mytilus edulis

Sideswimmer
Gammarus

Additional material no. 2

Salinity of the Baltic Sea



The salinity level of the distribution of some marine species in the Baltic Sea

The salinity of sea water is measured in promilles (‰).
1 promille = 1 g of dissolved salts per 1 kg of water. The salinity of oceans (incl. the North Sea) is on the average 35‰, i.e., each kilogram of water contains 35 grams (about 5 tablespoonfuls) of salt.

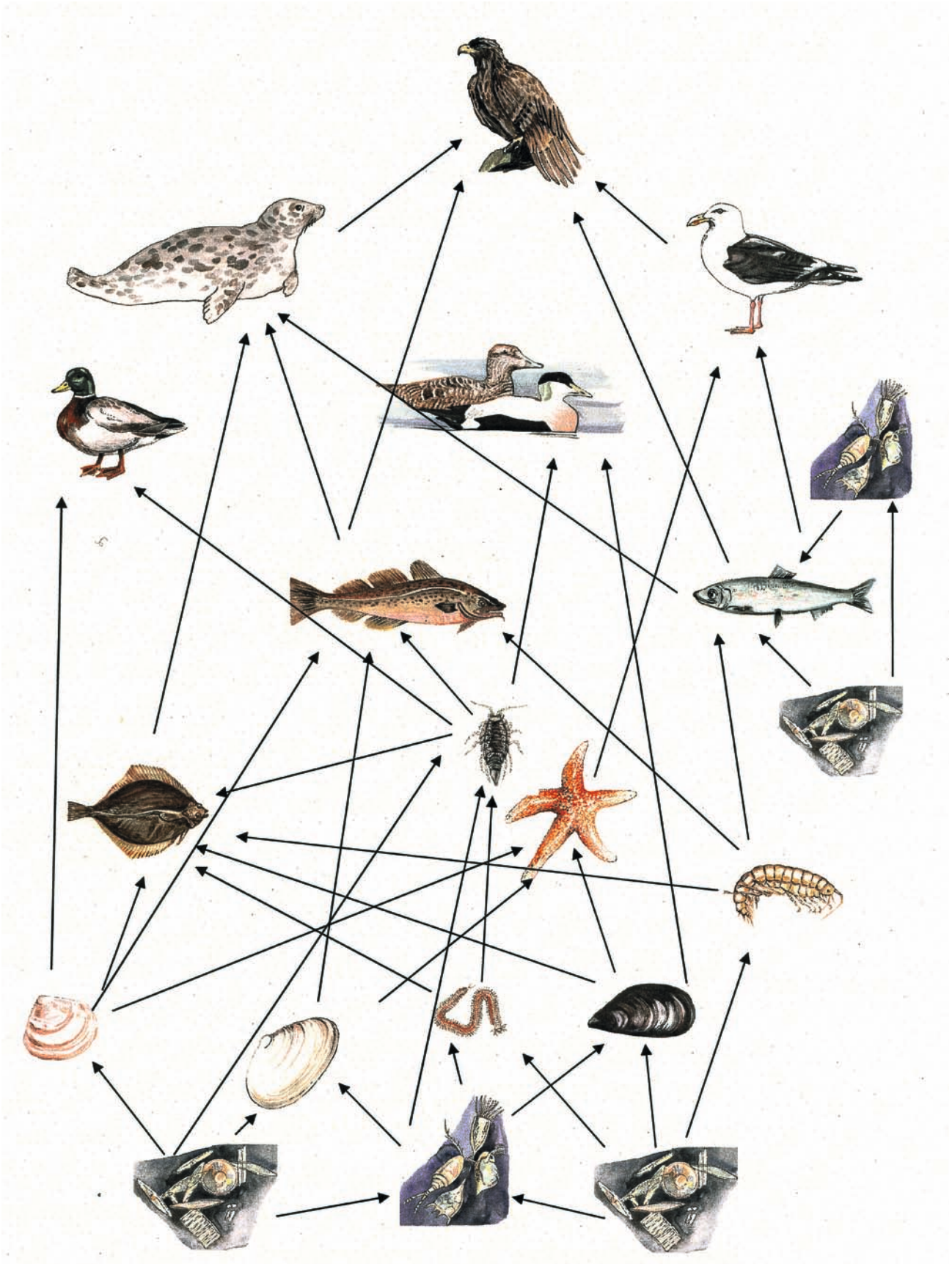
The salinity of the Baltic Sea is the lower, the farther to the East and North: in the North Sea the salinity is 35‰, in the Belts – 20‰ , in central Baltic Sea – 6–15‰, in the arms of the Gulf of Finland – 3–2‰.
Water with 0.5–18‰ salinity is called brackish water. Most of the Baltic Sea consists of brackish water.

The salinity preferences of water organisms differ and the salinity of a waterbody has significant effect on the distribution of water organisms. In the brackish waters of the Baltic Sea, some species are euryhaline marine species, some euryhaline freshwater species and some are brackish water species. The less salty the water becomes, the less typical marine species there are as the share of freshwater species which tolerate certain salinity grows.

Salinity affects the growth and development of organisms. Decrease of salinity causes stress to marine species while increase of salinity stresses freshwater species. Under extreme conditions, **plants and animals may often dwarf**, i.e., their measures decrease considerably.

Additional material no. 3

Feeding relations in the Baltic Sea



Additional material no. 4

Helpcards to arrange food chains "who eats whom"?

COCKLE

GREY SEAL

ZOOPLANKTON

ZOOPLANKTON

PHYTOPLANKTON

PHYTOPLANKTON

WHITE-TAILED EAGLE

COMMON FLOUNDER

GREAT BLACK-BACKED GULL

COMMON STARFISH

BLUE MUSSEL

Date: Members of the work group:

1. Determine the invertebrate animals of the Baltic Sea you find in the observation box / magnifying boxes.

Use additional material No. 1 (Picture guide to the invertebrates of the Baltic Sea) and other guides or posters, if displayed.

1.

2.

3.

4.

5.

2. Taste different water samples from different parts of the Baltic Sea.

Which parts of the Baltic Sea do water samples A, B and C come from?
Why did you decide so? Use additional material No. 2 (Salinity of the Baltic Sea).

Sample_____ is from the **Gulf of Finland** because_____

Sample_____is from the **Belts** because_____

Sample_____is from the western coast of **Saaremaa, Lõuka bay because**_____

_____

3. Why are the shells of the adult marine blue mussel up to 4 cm long on Estonia's western coast, though they are up to 9 cm on Sweden's south coast?

Use additional material "Salinity and fauna of the Baltic Sea" 2 for help.

_____

4. Prepare two food chains on the fauna of the Baltic Sea.

The food chain must have between 5 and 6 links and be characteristic of various regions of the Baltic Sea: one in the Gulf of Finland, the other in the Belts.
Use the following links of the food chain so that all the listed species and groups are covered: cockle, grey seal, zooplankton (drifting animals), white-tailed eagle, common flounder, great black-backed gull, phytoplankton (drifting plants), common starfish, zooplankton, phytoplankton, blue mussel.

Use the food chain graph in additional material No. 3 (Feeding relations in the Baltic Sea) and the tabs with species from the envelope.

Food chain of the Gulf of Finland: _____

Food chain of the Belts: _____

5. Use a magnifying glass to explore the invertebrate animal in the Petri dish.

Who is that animal? Use additional material No. 1 (Picture guide to the invertebrates of the Baltic Sea) for help.
See loom on _____

*6. Computer task.

To conclude this topic, watch short clip No. 4 'Aquatic sowbug' from the series 'See the Sea'.

3.3. Fishes of the Baltic Sea

Materials and instructions

1. "Fishes of the Baltic Sea", additional materials No. 1, 2 and 3 (respectively pp. 19-22) One-sided printouts to be placed in the ring binder or laminated and assembled in the folder of this learning centre.

2. Four numbered washable light-colored trays, flower pot saucers or similar to display four fish species.

3. Fishes for observation:
   on tray 1: two Baltic herrings
   on tray 2: two sprats
   on tray 3: one Baltic flounder
   on tray 4: one Baltic pipefish

   Baltic herrings, sprats and various flounders are available in fish markets and fish shops. Pipefish is sometimes caught as bycatch in the nets laid out by fishermen and ichthyologists and getting them is a task on its own and might require cooperation with scientists and fishermen. Broadnosed pipefish and straightnosed pipefish are both slim "dry" fishes and can be preserved for lengthy periods of time in spirits from where they can be retrieved before use. Other fishes procured beforehand must be preserved in a deepfreezer until use; fishes from the previous or same time should be put in the fridge.

4. Coloured papers (preferably laminated) to observe the reflection effect of the Baltic herring.

5. Some magnifying glasses, blunt end tweezers to observe the fish.

6. A dark-coloured (navy, dark green, grey or black) smaller bucket or deeper bowl to experiment with and observe the cryptic coloration of the Baltic herring.

7. Paper napkins or household paper to clean the hands on the go.

8. Water (faucet) and soap to wash the hands; cool water for the bucket.

9. Some eelgrass for tray 4 to display together with a broadnosed pipefish or a straightnosed pipefish.

10. Copied worksheets.

11. In addition, fish-themed books may be displayed.

Additional material no. 1

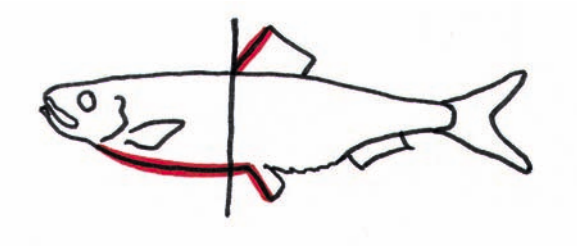
Baltic herring and sprat

There are about 100 species of fish in the Baltic Sea; around 70 species have been seen around Estonian coasts.
The most important commercial fishes of the Baltic Sea are: **sprat, Baltic herring, cod, flounder** and **salmon**.

Baltic herring and sprat are among the most important commercial fishes of the Baltic Sea so they are relatively small in size. But there are lots of them! One Baltic herring spawns between 15,000 and 90,000 eggs a year and lives up to 20 years.

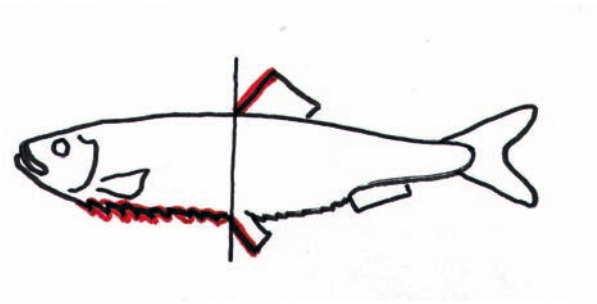
How to differentiate between a sprat and a Baltic herring?

Baltic herring



- The belly is relatively smooth, running your finger lightly from the tail to the head the scales cannot be felt very much against the skin.
- the pelvic fin is slightly in front of the *dorsal* fin.

Sprat



- the belly has a ridge of scutes, the scales are very noticeably felt while running your finger lightly from the tail to the head.
- the dorsal fin is level with the pelvic fin.

Additional material no. 2

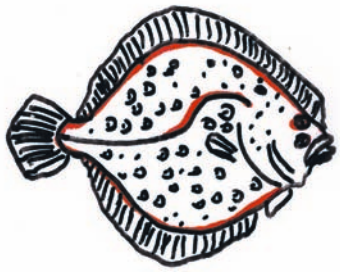
Flounders (*Pleuronectidae*) of the baltic sea

The body of the flounders is strongly flattened. The freshly hatched flounder fries have eyes on the both sides of the head and the body is not flat. As the flounder grows, its eyes migrate to the one side, the body undergoes a metamorphosis and as an adult, a flounder lies on the one side. The bottom side of the flounder is lighter in colour.

The food of the flounders depends on the place of habitat and age. Young flounders eat mostly larva of buzzer midge, water fleas, copepods and Gammarus. Aquatic sowbugs, bivalve molluscs and small fishes complement the menu of the older flounders. The jaws of the flounders have small sharp teeth to crush the shells of molluscs.

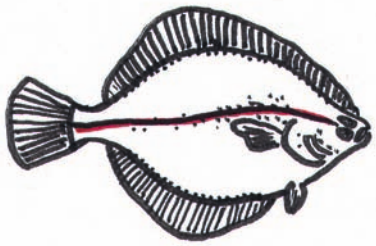
There are four types of flounders in the Baltic Sea.
Key to the flounders of the Baltic Sea

Turbot



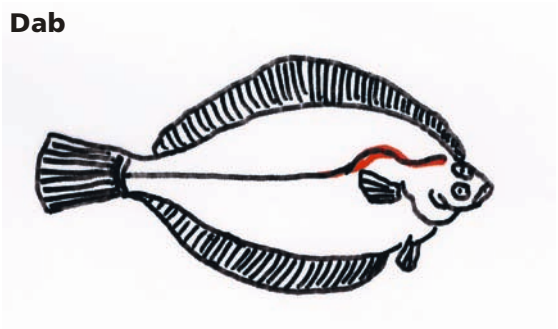
- Eyes on the left side.
- Lateral line curved.
- The most round body among our flounders
- Hard scutes on the body and head (small sipines).
- Colours vary .

Common flounder



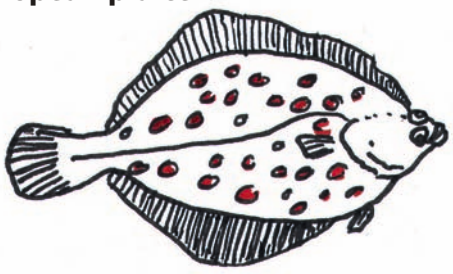
- Eyes on right (in most cases) or left side.
- Lateral line straight or slightly curved.
- Skin rough.
- Colours vary, no clear read botches.

Dab



- Eyes on right (in most cases) or left side.
- Lateral line makes a sharp upwards arch above the pectoral fin.
- Skin rough.
- Colour varies.

European plaice



- Eyes on right (in most cases) or left side.
- Skin smooth on head and body.
- In colouring, distinct dark or light red round.
- specs against olive brown.

Additional material no. 3

Pipefishes (*Syngnathidae*)

The fishes in the family of Syngnathidae have **a very long and slim body** resembling a thick needle (for instance, broadnosed pipefish and straightnosed pipefish) or have a completely distinct appearance bringing to mind the chess piece of 'knight' (lined seahorses). They have a **prehensile tail and a long tubular toothless snout** to suck food in. Their preferred food is larger plankton organisms, usually small swimming crustaceans. The body of pipefishes is covered with **bone plating** which forms either a full or partial armour. The body shape, colour and slow drifting of pipefishes imitate the surrounding algae and eelgrass, which allows these not very mobile fishes to successfully avoid enemies.

The reproduction of pipefishes is peculiar as the **roe and fry are always tended by the male fish**. When spawning, the female places the eggs on the belly of the males (straightnosed pipefish) or in a hatching pouch (broadnosed pipefish, lined seahorse). The male carries the offspring until the fry is hatched and beyond, watching over the young until they become independent.

There are two types of pipefishes in the Baltic Sea. Broadnosed pipefish Syngnathus typhle and straightnosed pipefish Nerophis ophidion.

There are no lined seahorses in the Baltic Sea.

Key to the pipefishes of the Baltic Sea.

Broadnosed pipefish

- Pectoral fins.
- Caudal fin rounded.

Straightnosed pipefish

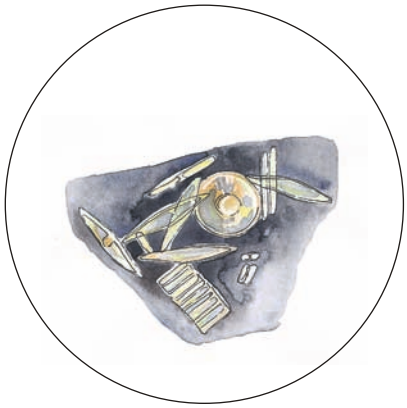
- Mature fish has neither pectoral fins nor a caudal fin.

Additional material no. 4

Menu choices for fishes

1. Menu

Phytoplankton



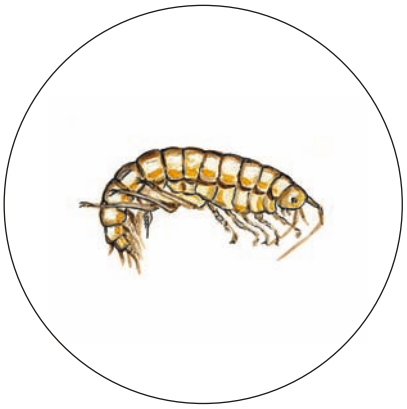
Zooplankton

Gammarus

2. Menu

Aquatic sowbug

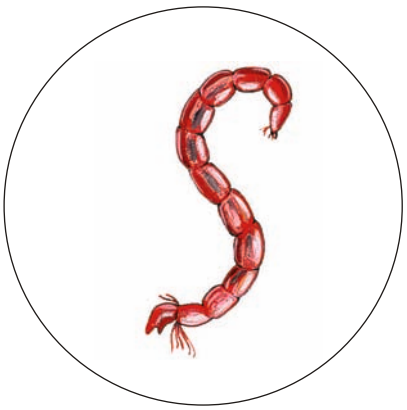
Gammarus



Blue mussel

Baltic macoma

Larvae of buzzer midge



Date: Members of the work group:

1. Identify which tray (1 and 2) has Baltic herrings and which has sprats.

Use additional material No. 1 (Baltic herring and sprat) and your hands.

Tray 1 has_____

Tray 2 has_____

2. Explore the Baltic herring (you may use a magnifying glass). Which colours do you notice on the back of the Baltic herring?

_____

Place two Baltic herrings in the water bucket so that one fish is back up and the other is belly up. The other observer should try to take a glance into the bucket from as high as possible (imagine that you are a gull).

Which fish would it notice first? Why?_____

_____

Now imagine that you are a cod that looks at the same fishes from the underside.

Which fish would it notice first? Why?_____

_____

3. Align some coloured papers to the Baltic herring (see the Figure!) and observe the colour of the fish.

Kas kala värv muutub?_____

What do you think, is this caused by the …

- Baltic herring changing its colour
- the scales of the Baltic herring reflecting the colour of the surroundings,
- the Baltic herring being transparent

Why is such an ability useful?_____

_____

4. Look at the fish on tray 3 and determine, using additional material No. 2 (Flounders of the Baltic Sea), which of the four species of Baltic flounders we have on our learning desk.

This fish is_____ What is its body shape like?_____

Find the dorsal fin and soft belly part of the flounder.

Does the flounder have its eyes on the right or left side?_____

Which side did the flounder lay in the bottom of the sea during its lifetime? Give reasons for your opinion._____

Explore the skin of the flounder with a magnifying glass and touch it with your hand.

What is it like?_____

The flounders can change the colour of their dark side to match the colour of the surroundings. What would it be good for?_____

5. What is the species of the Baltic fish on tray 4? Use additional material No. 3 (Pipefishes) for help.

Tray 4 has_____ What does this fish eat?_____

How does it relate to the eelgrass next to the fish?_____

What is this fish's peculiarity in reproduction and taking care of the offspring?

_____

Which peculiarly shaped fishes of the tropical seas are close to the fish on our tray in terms of classification?_____

6. Complete the comparative table for the Baltic herring, flounder and pipefish

	Baltic herring	Flounder	Straightnosed pipefish
Body shape			
Body covering			
Colour			
Teeth			

Wash your hands!

7. Look at the two menus in additional material No. 4 (Menus for fishes). Which of them would be suitable for Baltic herrings, which for flounders?

Menu 1 suits_____

Menu 2 suits_____

***8. Computer task.**

To conclude this topic, watch short clip No. 9 "Baltic herring" from the series "See the Sea".

3.4. Fishes of the Baltic Sea II

Materials and instructions

1. Additional material No 1 (p. 26) to "Fishes of the Baltic Sea II". One-sided printouts to be placed in the ring binder or laminated and assembled in the folder of this learning centre.

2. Ten numbered washable light-coloured trays, flower pot saucers or similar to display four fish species.

3. The fishes needed for observation are listed by their tray numbers as some of the worksheet tasks require that there is a certain species on a certain tray. Naturally only those fishes can be used you were able to procure. The rest of the trays are not used and correspondingly the tasks that cannot be completed because of the unavailability of the fish should be crossed out in the worksheets.

On tray 1: three-spined stickleback
On tray 2: lumpsucker
On tray 3: eelpout
On tray 4: smelt
On tray 5–10: fourhorn sculpin, perch, ruffe, roach, nine-spined stickleback, river lamprey.

Three-spined sticklebacks, eelpouts, smelts, ruffes, fourhorn sculpins and lumpsuckers can often be found in the bycatch of the Baltic herring. You may ask for them from the sellers at the fish market as our experience is that they are quite happy to pick them out from the crates for study purposes.

Smaller perches, lampreys and roaches can be bought at the fish market.The fish may be preserved in a deepfreezer and taken from there before use to melt (they should be washed before placing on the trays). After completing the tasks, the fish may be used, for example, as cat or chicken food. Three-spined sticklebacks and nine-spined sticklebacks may be preserved in spirits and reused.

4. Some magnifying glasses, blunt end tweezers to observe the fish.

5. Fish field guides, such as "Eesti NSV kalad" ('Fishes of the Estonian SSR) (colour plates) and "Eesti mageveekalad" ('Estonian Freshwater Fishes').

6. In addition, you may want to use the study folder "Fishes of the Baltic Sea", fish posters or other fish-themed materials.

7. Paper napkins or household paper to clean the hands on the go.

8. Water and soap to wash the hands (faucet).

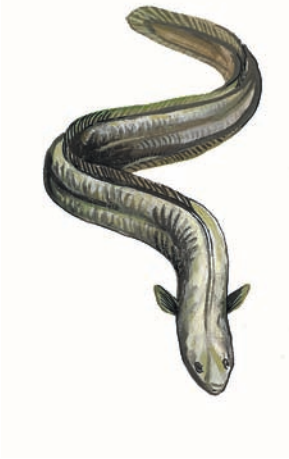
9. A blue and a green pencil/feltpen/marker.

10. Copied worksheets which should indicate which of the tasks are to be completed (depending on which fish you were able to procure for display).

Additional material no. 1

The fishes of the Baltic are of different origin: some are ocean species that have relocated to the Baltic Sea and some are freshwater species. Furthermore, there are migratory fishes which during the reproduction period travel between the sea and freshwater bodies.

Origins of the Baltic fishes

Fishes of marine origin	Fishes of freshwater origin	Migratory fishes
Baltic herring Sprat Cod Flounder Turbot Dab Plaice Bull-rout Sea scorpion Fourhorn sculpin Eelpout Gunnel Snake blenny Sand goby Black goby Two-spotted goby Lumpsucker Sea snail Common sand eel Lesser sand eel Greater sand eel Broadnosed pipefish Straightnosed pipefish Sturgeon Sea lamprey	Vendace Whitefish European whitefish Char Grayling Pike Smelt Bream Zope Bleak Asp White bream Crucian carp Gudgeon Ide Chub Razorfish Minnow Roach Rudd Tench Spined loach Stone loach Wels Burbot Three-spined stickleback Nine-spined stickleback Perch Ruffe Pikeperch Bullhead	**Anadromous fishes** migrate from the sea to freshwater bodies to hatch. Salmon Sea trout Grayling Whitefish Vimba bream River lamprey **Catadromous fishes** migrate from freshwater bodies to the sea to hatch. **Eel** 
Eelpout is the only Baltic fish with in vivo fertilization and to give live birth. 	With **three-spined sticklebacks** the male fish is the one to build a nest from plants in the bottom of the sea and take care of the fry. 	**Eels** travel to hatch from European (also Estonian) rivers into the western part of the Atlantic Ocean – the Saragossa Sea.

Date: Members of the work group:

Use the additional materials and books provided for you.

1. Who is on tray 1?_____

Which parent of this fish takes care of the offspring?_____

2. Who is the fish on tray 2?_____

If you were to describe it to someone who has never seen it, how would you characterize this fish? Note down at least three characteristic features of the fish. Look for its sucker!

_____

_____

3. Who is the fish on tray 3?_____

What is unique about this fish reproduction?

_____

4. The fish on tray 4 is smelt.

Use a magnifying glass to look if you see its brain. The skull of a smelt is quite transparent.Freshly caught smelt smells like fresh cucumber. Smell the smelt. Does it smell differently from the other displayed fishes?

_____

5. Which fishes are on the following trays?

Tray 5 has _____ Tray 6 has _____

Tray 7 has _____ Tray 8 has _____

Tray 9 has _____ Tray 10 has _____

6. Mark in blue those of the explored fishes which are Baltic fishes of marine origin and in green those who are freshwater species by origin.

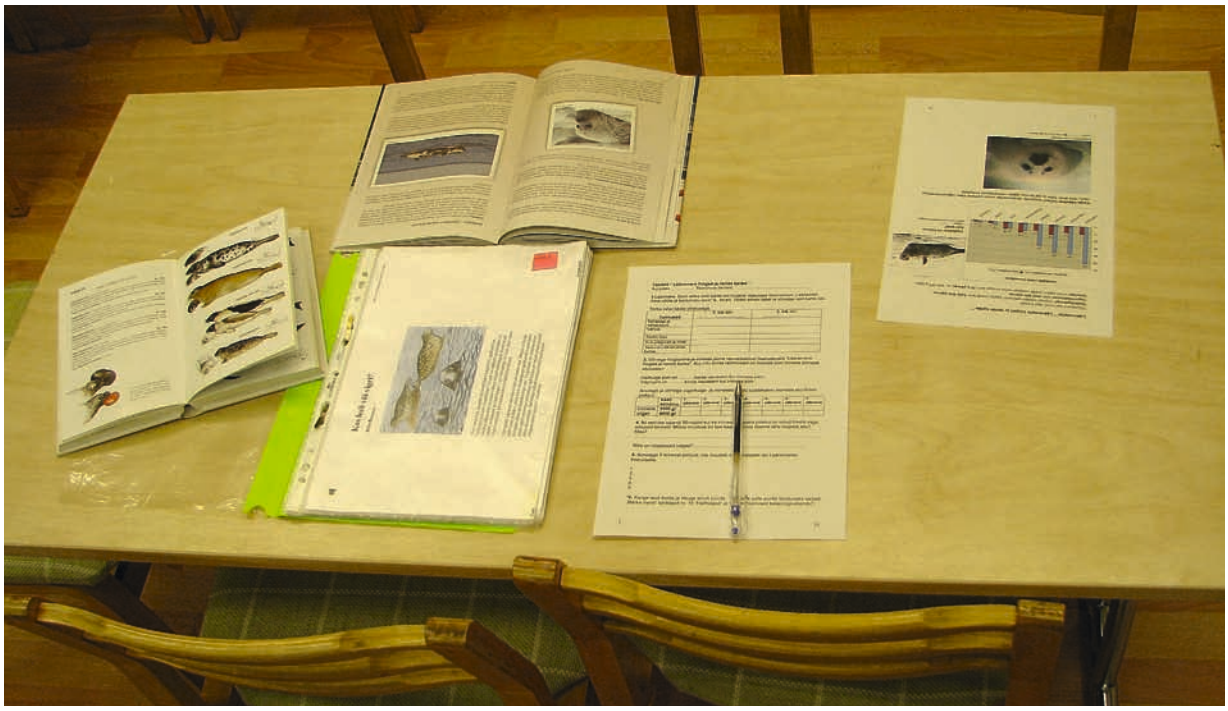
7. Which of the following Baltic fishes has any of the members of your work group ever eaten?

Underline the fishes you have tasted and eaten.

Species of marine origin: Baltic herring, sprat, cod, flounder, turbot, dab, plaice, bullrout, sea scorpion, fourhorn sculpin, eelpout, gunnel, snake blenny, lumpsucker, sea snail broadnosed pipefish, sturgeon.
Species of freshwater origin: vendace, whitefish, grayling, pike, smelt, bream, bleak, asp white bream, crucian carp, gudgeon, ide, minnow, roach, rudd, spined loach, stone loach, wels, burbot, three-spined stickleback, perch, ruffe, pikeperch, bullhead.
Migratory fishes: Salmon, sea trout, grayling, whitefish, vimba bream, river lamprey, eel.

3.5. Baltic seals and their protection

Materials and instructions



1. "Baltic seals and their protection", additional material No. 1 (p. 29) One-sided printouts to be placed in the ring binder or laminated and assembled in the folder of this learning centre.

2. The Book "See the Baltic Sea. Unique assets we share" to be printed out from the Internet www.visitbalticsea.net/download/Book_EN.pdf, required reading for the learning centre: pp. 39–43.

3. Besides you may want to use, for example, a baby seal plush toy (in baby fur), or other relevant seal-themed teaching aids and articles.

4. Copied worksheets.

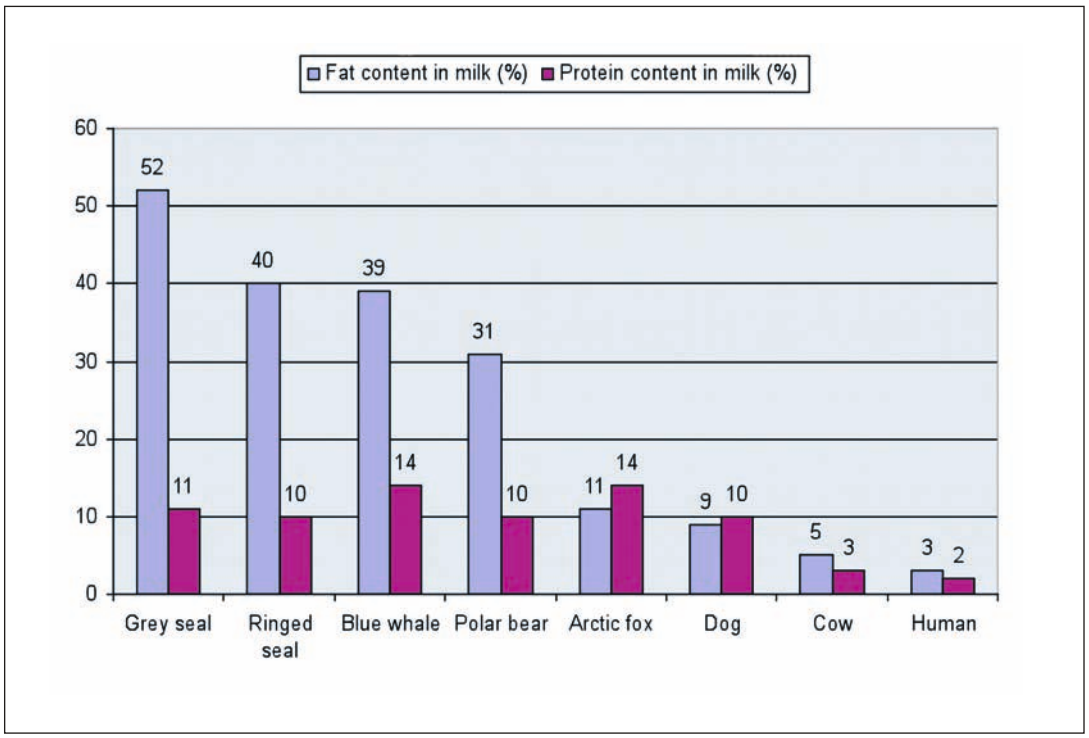
Additional material no. 1

Baby seals grow very quickly.
Grey seal pups gain **up to two kilos** of body weight during lactation period; **ringed seal pups** up to **half a kilo a day**.
A **human baby** gains up to **30 g/day** of body weight during the first four months, i.e., between 600 and 900 g/month.

White fur protects the baby seal from overheating in the bright sun of early spring and helps remain unnoticed to predators against the snow and ice.

A grey seal has grown quickly

A seal pup in baby fur



Date: Members of the work group:

1. Two seal species inhabit the Estonian waters of the Baltic Sea. Use additional material "See the Baltic Sea. Unique assets we share", pp. 39–43. Complete the table below and compare the two species.

Fill in the table, comparing the species

Features	Species 1 (name of species):	Species 2 (name of species):
Body weight and body length		
Colour		
Shape of snout		
Farrowing, where and when		
Status in the Baltic Sea protection		

2. Compare the fat content of seal milk and human milk from the additional material "Baltic seals and their protection". How many times higher is the fat content of seal milk compared to that of human milk?

The milk of grey seal is by _____ times fatter than human milk.
The milk of ringed seal is by _____ times fatter than human milk.

3. Calculate and compare the weight gain of a ringed seal baby and a human baby during the first week of life.

	Newborn	1-day	2-day	3-day	4-day	5-day	6-day	7-day
human	3500 g							
ringed seal	4500 g							

4. Both in the 90s of the previous century as well as during the past ten years Estonia has had very mild winters.

Which change has this introduced into the life of the seals of the Gulf of Finland? Why?

_____

Why are seal pups white?_____

5. Name five reasons that make life complicated for marine mammals in the Baltic Sea.

1.
2.
3.
4.
5.

***6. Computer task.**

To conclude this topic, watch short clip No. 15 'Grey seals' from the series "See the Sea" and No. 16 "Alternative fishing gear".

3.6. The Baltic fauna is in constant change

Materials and instructions

1. "The Baltic fauna is in constant change", additional material No 1 (p. 32). One-sided printouts to be placed in the ring binder or laminated and assembled in the folder of this learning centre.

2. The manual "Vee võõrliikide käsiraamat" ('Manual of Alien Species') published by the Ministry of the Environment in 2011 can be downloaded and printed out from Internet at: www.envir.ee/orb.aw/class=file/action=preview/id=1169271/voorliigid+vees+veeb.pdf.

3. A globe, a pocket calculator, cord of appr. 70 cm length, and a measuring tape.

4. "A collection of Baltic aliens": a selection of some alien species of the Baltic Sea which you manage to collect (desiccated zebra mussel, sand gaper, New Zealand mud snail, Chinese mitten crab).

5. Copied worksheets.

6. In addition, you may want to use a world atlas and additional material on the Suez canal

Additional material no. 1

Many of the now common Baltic species have arrived here from places very far away. The fauna in the Baltic Sea has been and will be in constant change.

As the shipping activities intensify in the Baltic Sea, the challenges posed by **invasive alien species** have become increasingly relevant. Cargo vessels release through their ballast waters unwanted guests who may reproduce massively and cause imbalances in the local marine ecosystem.

Alien species are generally very viable. Provided that the conditions are suitable, **up to 10% of the brought-in species manage to survive** and of them, in turn, about **one tenth becomes mass species**. Sometimes the introduction of a new species may cause significant changes in the established biocenosis.

Sand gaper *Mya arenaria* is likely to have arrived into the Baltic Sea with the Vikings from the **North-American coast** in the 11th/12th centuries. It has adjusted very well here and has become a very abundant species.

Mud snail *Potamopyrgus antipodarum* is originally from **New-Zealandian** waters. It was for the first time found in the Baltic Sea back in 1887. It may live in waters with very varying degree of salinity and is fairly resistant to changing environment. This small snail of up to 5 mm in length can be very abundant at places, however, it has not significantly affected the balance of the Baltic fauna.

Warty comb jelly *Mnemiopsis leidyi* was for the first time found in the Baltic Sea in 2006. It arrived here with ships from North-America. Warty comb jelly endangers the populations of Baltic herring and sprats as it feeds on the same diet as they. According to studies, it can also feed on the eggs and larvae of sprat and cod. It has no natural enemies in the Baltic Sea and thus it has massively and quickly reproduced.

Chinese mitten crab *Eriocheir sinensis* has arrived here from **China** or **Korea**.
Chinese mitten crabs destroys dams, breaks fishing gear and damages the fish caught in the gear. It clogs water pipes connected to water bodies during multiple migration. Destroys fishes and their food in fish farms.

Date: Members of the work group:

1. Which of these – the sand gaper or New Zealand mud snail – travelled longer to reach the Baltic Sea (and by approximately many times longer)?

Use the globe and the cord, and bear in mind that the New Zealand mud snail passed through the Suez canal. You should consider that they arrived with ships so you may want to use the sea lanes! Also make use of the additional materials.

The **Suez canal** is a waterway in Egypt connecting the Mediterranean Sea and the Red Sea. The length of the canal is 163 km. It was built in 1859–1869. The first ship passed the canal in 1867. The canal was festively opened on 17 November 1869.

The migration travel length of the **New Zealand mud snail** was _____ cm on the globe = appr. _____ km.

The migration travel length of the **sand gaper** was _____ cm on the globe = appr.

_____ km.

_____ arrived by _____ times as far as _____

2. Let us assume that during the three previous years, ships from everywhere in the world released with their ballast waters 400 different species of water animals into the Baltic Sea and that three percent (3%) of them found the conditions of the Baltic Sea suitable.

We know that **about 10%** of the species **manage to survive** in a suitable environment. Calculate the probability of how many new species moved to stay into the Baltic Sea.

The number of species to have moved to live in the Baltic Sea during the past three

years is probably _____

*4. Computer task.

To conclude this topic, watch short clip No. 17 "Spiny waterflea" from the series "See the Sea".

3.7. Oil pollution in water

Materials and instructions

1. "Merereostustõrje käsiraamat" ('Manual on Marine Pollution Abatement'), can be printed out at http://www.elfond.ee/et/teemad/meri/laeaenemere-kaitse/naftareostus/merereostus-torje-kaesiraamat. Use stick-its on the printout to denote the places relevant to the worksheet to facilitate finding answers.

2. "Oil pollution in water", additional material No. 1 (p. 35).

3. Experiment tools.

   Dishes:
   a small shallow dish such as a coffee cup to mix the "mazut";
   two transparent glass or plastic jars, appr. 0.5L each;
   a funnel (you may cut off the top of a 1.5L plastic bottle);
   a small bottle with a pipet stopper (for ink or blue food coloring extract);
   a small trash can for the oily waste created during the experiment.

   Ancillary tools:
   a tablespoon, a teaspoon, long tweezers, small trays to keep the ancillary tools and cleaning agents tidy.

   Ingredients:
   cocoa powder;
   water (from the faucet);
   sea salt to imitate sea water;
   washing-up liquid (two bottles – one on the desk and the other by the sink to wash the utensils and tools after the work is completed);
   ink or the concentrate of blue food coloring extract to imitate seawater.

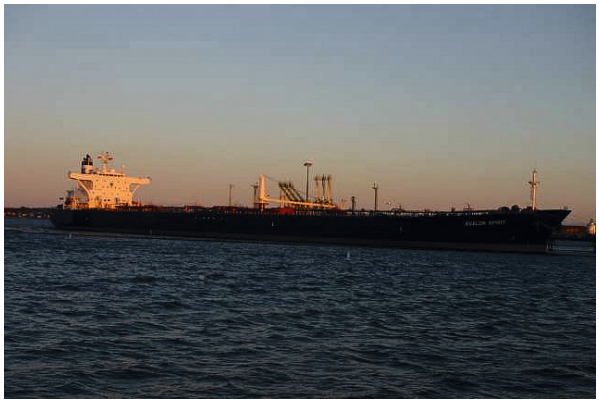
   Puhastusvahendid:
   cotton pads, pieces of dishwashing sponge, pieces of household paper, strips or rags of various textiles, coffee filters, etc.

4. Paper napkins or household paper to clean the hands, work surfaces and tools and utensils.

5. Water and soap to wash the hands (faucet).

6. Copied worksheets.

Additional material no. 1



An oil tanker

An oil terminal

How does oil get into the sea?

Oil gets into water bodies, *inter alia*, into the Baltic Sea from various sources:

- during marine accidents, in particular major accidents involving fuel tankers
- oil residues released from ships into the sea; during repumping of oil or from a ship's oily wash water or residual water
- a part of the oil pollution originates from the land, carried into the sea by rivers
- pollution may also spread around oil boreholes and platforms

Detection and liquidation of oil pollution.

Detection, monitoring and documentation of oil pollution from air are carried out with specially equipped planes. Oil leaks often happen during the night or in fog and special equipment is required to detect them properly. Also the information received from all of the ships is important, as is port security.

In order to document an oil spill, the entire incident needs to be recorded and documented (videos, photos). Pollution samples are to be obtained from the sea and suspected vessels. The polluter is identified in court against evidence. The court also issues penalties and damages for creating pollution – generally, in case of oil pollution they are awarded damages in millions of euros.

Oil pollution contaminates large areas of sea, damaging marine biota, coasts and fishing. After oil pollution has occurred, it is the birds smeared with pollution that struck the eye most.

What happens to the oil that has leaked into the water? After the highly volatile substances have evaporated, the oil forms sticky clots, hardens and sinks into the bottom. Unfortunately not much is known about the nutrient cycles the degradation components of oil residue enter into.

In order to liquidate oil pollution, the contaminated area is sealed off. The intensity of waves and winds affects the efficiency of the operations. Where possible, a part of the oil pollution is pumped out of the sea while attempting to prevent the oil residue from hardening and spreading over large areas. Hardened oil washed up the shore is gathered together and burnt. Solid sorbents (absorbent porous substances) which bind the oily residue are also used to catch oil from water.

Date: Members of the work group:

Oil pollution and options to liquidate it.

Read through additional material No. 1 "Oil pollution in water"

1. From where can oil get into water?_____

_____

_____

Read about oil pollution and oil properties in "Merereostustõrje käsiraamat" (p. 8).

2. Which are the basic properties of oil and most oil products?

A _____

B _____

C _____

D _____

3. What does 'volatilization of oil' mean?_____

PRACTICAL WORK

Your research task is to observe the behaviour of oil in water and experiment with various options to liquidate oil pollution.

Experiment 1. Modelling an oil spill.

Take a clean **glass jar filled with faucet water** and add a drop of blue ink. Also add some salt (about 1 tsp per a 1.5L jar) to imitate sea water. Mix and let the solution settle.

How does sea water differ from faucet water? Find between one and three differences. _____

In a cup mix thoroughly two teaspoonfuls of cooking oil and two teaspoonfuls of cocoa powder – this yields the "mazut" you will need for the experiment.
Take a spoon to help you. Let the oil mixture or the "mazut" transfer very slowly (1) from the spoon, at the height of about 1 cm, onto the surface of the "sea water" in the glass jar. NB! If you pour too quickly or from too high, the experiment will fail and you need to start all over.

What happened after you released the oil into the sea water? Did the oil remain on the surface, sink or mix with the water?

_____

Wait three minutes.
Are there any changes in your "experimental sea"?_____

Experiment 2. Liquidating an oil spill.

Take turns using various sorbents or absorbent materials and other ancillary tools (**cotton, dishwashing sponge, spoon, newspaper, rag**) and try to remove the oil from water. Use the tweezers. Put the used cleaning utensils into a small trash can for the time being. Imagine the feasibility of using the same tool or technique in real sea.

Grade the efficiency of each cleaning utensil. Add comments where necessary.

Grade Utensil, method	Poor	Average	Good
Cotton			
Dishwashing sponge			
Spoon			
Newspaper			
Kalts			

How much of the oil did you manage to remove from the water?_____

Which of the utensils do you consider the most effective?_____

Place a clean **coffee filter** into the funnel and the funnel itself into a clean jar and pour about one third of the partially cleaned water of your “mazut-polluted sea” onto the filter. Wait patiently as the oily water drizzles through the filter. Describe the outcome.

How did your cleaning method work?_____

Could this method be applied to an actual oil spill?_____

Until now you cleaned the “sea” manually. Now try to clean the remaining two thirds of the “sea water” chemically, i.e., use the **washing-up liquid**. Let some drops drip into the water. Mix well.

What happens?_____

How clean is the water after using the washing-up liquid?_____

Conclusions

Is it easy or difficult to liquidate an oil spill? Give reasons for your opinion.

_____

_____

Read additional material No. 1 (Detection and liquidation of oil pollution).
How is oil pollution liquidated on sea and shore?

A _____

B _____

C _____

How do you detect oil pollution?_____

3.8. Impact of oil pollution on marine organisms

Materials and instructions

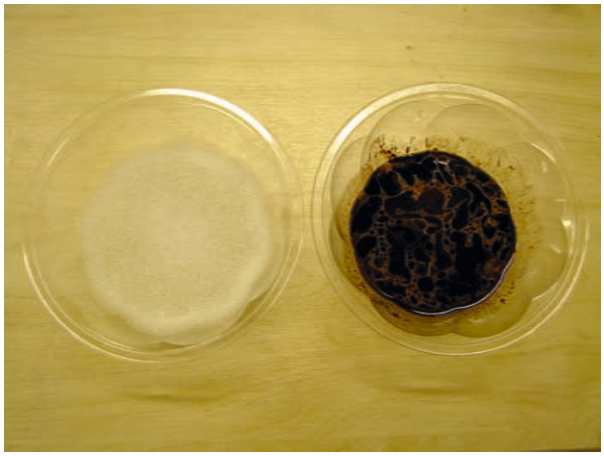
1. "Merereostustõrje käsiraamat" ('Manual on Marine Pollution Abatement'), can be printed out at http://www.elfond.ee/et/teemad/meri/laeaenemere-kaitse/naftareostus/merereostus-torje-kaesiraamat. Use stick-its on the printout to denote the places relevant to the worksheet (pp. 6–7 and 27) to facilitate finding answers.t

2. Experiment tools.
   A bowl or any other small dish filled with water into which the "mazut" mixed from cooking oil and cocoa powder or oil mixtures with different densities are poured;
   bird feathers (down and contour feathers; ask the keepers of pet birds or poultry for fallen feathers); a jar with a lid to store the feathers;
   a small bowl to wash the feather;
   washing-up liquid;
   a dry blower to dry the feather;
   a stereoscopic binocular to observe the feather; Petri dishes to place the feather under the binocular for observation;
   a teaspoon, long tweezers, small trays to keep the tools tidy.

3. Paper napkins or household paper to clean the hands, work surfaces and tools and utensils.

4. Water and soap to wash the hands and tools (faucet).

5. Copied worksheets.



Washig water and oil water

Date: Members of the work group:

Read "Merereostustõrje käsiraamat" (pp. 6–7 and 27) and answer the following questions:

How do oil and oil products affect various organisms if spilt into the sea?

Plankton?_____

Fish?_____

Birds?_____

Mammals?_____

What is the long-term effect of oil pollution?_____

Experiment. Effect of oil on a bird feather.

1. Explore a clean contour feather and down feather of a bird under a stereoscopic binocular: How does a feather form a whole, what are the attachments, barns, fluff like?

2. Dip one contour feather and one down feather into the "oily" water in the bowl and explore them under the binocular.

Did the structure of the feather change? If yes, how?_____

Which type of feather changed more in the oily water?_____

3. Try washing the feathers with the washing-up liquid and water and then dry (with a dry blower).
Did the feather restore its original shape and structure?_____

Why is oil pollution dangerous to water birds?tt

Conclusions.

What happens to an oily bird on the sea (based on the results of your experiment)?

_____

What causes the death of an oily bird?_____

Can a bird be cleaned from oil?_____

3.9. Poster to support the Baltic Sea

Materials and instructions

1. The guide "Poster to support the Baltic Sea" serves as the additional material (p. 41). One-sided printouts to be placed in the ring binder or laminated and assembled in the folder of this learning centre.

2. Materials for the poster:
   poster paper, at least size A3;
   markers, crayons, poster paints, scissors;
   coloured papers, old magazines or advertisements to make a collage;
   paper glue (gluesticks or PVA).

3. In addition, you may want to use different posters bearing different messages, some of them might be nature-themed.

4. Articles and books about the Baltic Sea and related challenges.

Guide

1. **Examine the materials on your desk**, however, you may refer to any of the books displayed in the lab for inspiration.
   Think of the meaning of the sea for you and whether it is important to you that the sea is protected and preserved.

   Each of you should name three pleasant things associated with the Baltic Sea.

2. **Prepare and execute a poster on the Baltic Sea.**

   1) Discuss and formulate the **message you wish to convey with your poster**.

   Recommended topics: The Baltic Sea and its protection; status and protection of seals or any other important species/group; Baltic Sea and oil pollution; Baltic Sea and poisons, your stance regarding the Nord Stream gas line; Baltic Sea and how we personally affect it; communication between man and environment.

   2) Devise a **clear and eye-catching design** of the poster; decide which elements are a must.

   3) Produce your poster using the tools and materials provided.

   4) Hang the poster in a suitable place in the lab.

What is a poster?

A poster is an artistic billboard, etc. displayed prominently in a visible place. Posters include both text and graphics; however, there may be posters that convey just text or only graphic elements.

An easy recipe for a poster:

Combine the following ingredients to taste:

- A clear message or idea
- Identification with the message conveyed
- Clear and simple wording (be moderate with the text)
- Eye-catching font or image
- Emotionally charged pictures, images, signs, patterns (beautiful, irritating, cute, sad, etc.)

If desired, spice up with

- humour
- vagary
- bluntness
- sharpness
- or something else

Serve in a visible place!

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Tartu Environmental Education Centre
2011

The project "Communicating the Baltic – COBWEB" is designed to work with universities, museums and nature schools, developing environmental education programs, teaching aids and materials.

Leading partners are Hyria College and partners of the Tartu Environmental Education Centre, Tallinn University of Technology Institute of Geology, University of Tartu, Environment Department of Tallinn, University of Latvia, Latvia's Natural History Museum, Harakka Nature Centre, the Finnish Capital Recycling Centre, the Villa Elfvik and Nynäshamn Nature School.

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Website www.hyria.fi/cobweb.

Tartu Environmental Education Centre
Telephone: +372 736 1693
e-mail: teec@teec.ee
www.teec.ee

Tartu Environmental Education Centre provides activities for:
Children and young people's extra-curricular activities at the Tartu Nature House
Natural and environmental information centre
Adult education

We organize exhibitions, lectures and film evenings, outdoor excursions and other public events in the city as well as nature curriculum for schools. For students we offer fun activities and exciting opportunities for discovering nature. Come and discover yourself in the wild!

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