The Danube Basin Ecosystem

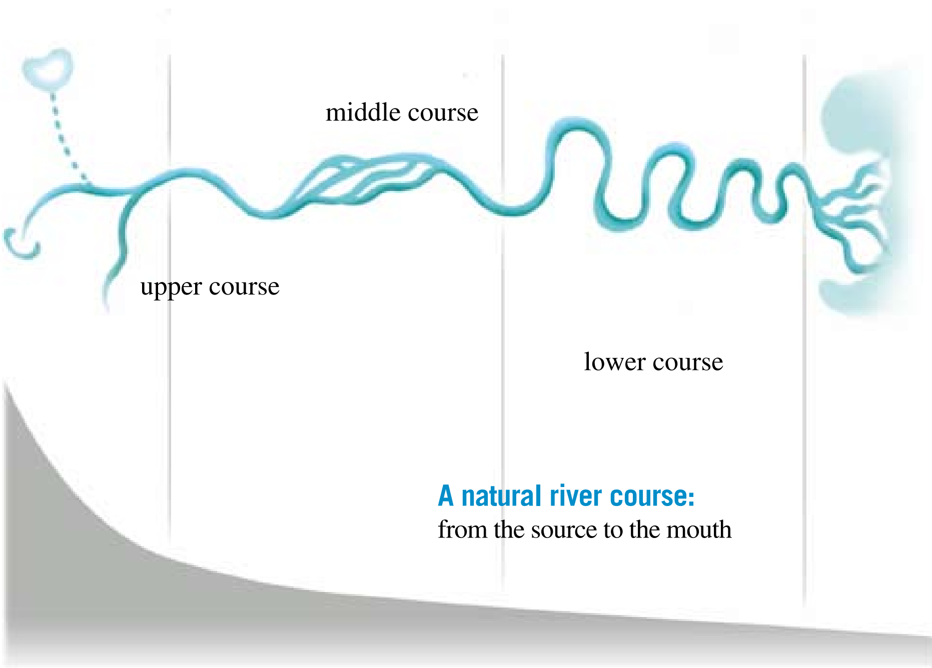
2

Types of river course 2.1.

2.1. **Types of river course**

Rivers have many faces

Flowing waters have formed the surface of the earth over millions of years. When mountains are created, there are always rivers cutting through the valleys between them. Whole mountain ridges and peaks continue into the valley through the abrasive power of water. Depressions and basins were filled with ground-down rock. Even today, rivers transport stony material, deposit it elsewhere and thereby shape the landscapes they pass. A river course can be divided into sections according to the energy with which the river works on its surroundings.



A natural river course:
from the source to the mouth

In the upper course, the riverbed usually runs straight; erosion (vertical cutting or deepening) usually predominates. In the middle course, the river divides into several arms (furcation) and it begins to flow in bends. Erosion and sedimentation (accretion) are in balance. In the lower course the river winds (meanders); sedimentation predominates. These geological processes are mainly responsible for different types of river course.

Objectives:

The children learn ...

✔ to distinguish between the geological processes of erosion and sedimentation in the development of types of river course and to recognise the formative effects of flowing water.

✔ to recognise the pattern of a river course on a map and to depict the course of a river through lowland in figures.

Materials:

Activity 1: baking tray, oven dish, two 5 cm x 10 cm supports, 2–3 small boards (3–5 cm high), 1 bucket (10 l), fine building sand, 1 water jug, water

Activity 2: map of the region around the school (scale 1:150.000–1:50.000), woollen thread, sticky tape (removable), pins, tape measure

Organisational points:

Duration: 2–3 teaching units

Location: classroom

Activity 1: Experiment
Flowing water as the architect of the landscape

Lay the supports under the baking tray front and back.

Place a board on each of the rear posts under the baking tray (approx. 3–5 cm high) to form an inclined plane. Place the oven dish under the front edge of the baking tray so that it stands out a little (the oven dish is to catch water and sand run-off).

Put sand on the baking tray. At the upper end the children let it form a gentle hill. Cover the whole baking tray with sand. Pack it down firmly and smoothly (important!).

At the top of the hill, slowly pour water out of the jug at one corner and observe how the water seeks its path as it flows away (this is similar to the way that natural riverbeds develop).

One by one, other children pour a jug of water onto the hill. In between each jug of water an observation team should record the changes in the surface of the sand (verbally or by drawing what they see).

The water seeks its path along the fall line. The lower the gradient, the more the channel develops a winding form through deposition and horizontal erosion.

- In the hill-section, a deep gully quickly develops (compare with depth erosion in the upper course).
- In the flat section, the superfluous sand is deposited in the form of islands (compare with forked course running through surplus sediment in the middle course).
- With a bit of luck, slight bends develop in the lower course through horizontal erosion (compare with meandering in the lower course).

The connection between gradients and the formative processes of a river is illustrated by using the sand model.

Tip: Different types of course can best be created by carrying out the experiment several times, each attempt with a different incline. The same experiment can also be carried out on the sandbank of a river.

Find more at "Additional informations for teachers": The sections of a river

Activity 2: Experiment
How long is my river really?

Water flows as it wants to. According to the inclination and the nature of the land, water flows straight or meanders. Besides the material of the riverbed and the water flow in the course of the year it is the gradient that determines what a river course looks like from a bird's-eye view.

Choose a lowland river with a meandering course on the map. Explain that this type of course occurs in basin areas and in the lower course of rivers. (Attention: incised meandering of rivers in the mountains have tectonic causes and is not dealt with here!)

If possible, look for points with altitudes at the beginning and end of the meandering stretch of river and note these down.

Mark the start of the stretch of river with a pin. Attach woollen thread to it with a knot and lay it down carefully on the map along the bends of the river. Repeatedly fix with sticky tape. Mark the end point with a second pin. >>>

Carefully remove the woollen thread and measure the length of the thread from pin to pin. Convert the length of the stretch measured into the real length according to the map scale.

Measure the same stretch from start (A) to end (B) with a second woollen thread, with the thread following the approximate course of the river without meandering. Calculate the real length of this stretch and compare it with the first measurement.

The measurement of the meandering stretch in comparison with the course of the river that doesn't meander should illustrate the reduction in habitat between the two stretches of river. A meandering river shows that the river has preserved its natural state.

Example: The course of the Tisza, a meandering lowland river in Hungary, was reduced from 1,420 km to 970 km as a result of regulation. This corresponds to a shortening of 32%.

There are many types of river: mountain streams, mountain rivers, gravel-bed rivers, sand-bed rivers. How can one differentiate between them?

Upper course (stream): Almost all rivers in the Danube basin originate from a mountain. In the beginning the river is a mountain stream. It flows down a steep valley. When snow melts and after heavy rain the stream carries so much water and flows so fast that it drags gravel and stones with it. The stones that are dragged along with the stream slowly dig its bed deeper; this is called depth erosion or vertical erosion.

Middle course (small river): When it reaches the valley floor, the mountain stream deposits its stones. The valley it flows in becomes shallower and the riverbed now consists mainly of gravel. As a result of water from tributary streams, the mountain stream has become a river and is already over 3 m wide. When it floods the river takes a great deal of grit and gravel with it and deposits it as islands or on the banks. Several arms of the river develop between the islands. Every flood changes the islands and the banks anew, so that no plants can grow there in the long term. Sometimes a river tears away a bank or an island; this is called horizontal erosion. If the river reaches a plain, then it deposits its masses of grit and gravel in a huge pile.

Lower course (large river): In the plain the river becomes a lowland river. The water runs sluggishly; it only has enough strength to carry sand and very fine gravel. The river develops a meandering course. If the flow hits the outside of the river bend (the cut bank), the material is eroded away and deposited on the inside of the following bend (the slip-off slope). Here again horizontal erosion is at work. When the river floods, a lot of fine, suspended material, called sedimentation, is deposited in the floodplain forest.

Delta: Sometime the river flows into the sea. The riverbed no longer has any gradient. The water no longer has the power to transport its large amount of solid material, and deposits it, forming sandbanks. Between these sandbanks, the river has to find its way into the sea and it divides into many arms. During floods, the land between the arms is flooded and a marsh develops.

Background information

Danube tales

Danube: border or connection? Danube friendship bridges

Bridges connect. They often include words such as friendship or freedom in their names, for example the "Friendship Bridge" between Ruse in Bulgaria and Giurgiu in Romania. The two countries on the banks of the Danube have not always lived in peace and mutual respect with each other.

On the Hungarian bank high above the Danube is the town of Esztergom (German: Gran; Slovakian: Ostrihom). Opposite, on the low Slovakian side, is the village of Štúrovo (German: Parkan; Hungarian: Párkány; Slovakian until 1945 Parkan). If one wanted to get from one side to the other, until a few years ago one had to take the ferry. But two pillars have stood in the Danube for a long time, as if to remind us of a bridge that once stood there. There were simple bridges in the past and sometimes temporary crossings, which from time to time were destroyed by armies passing through. In 1895 the first permanent iron bridge was completed. For the 110 years that have passed since then, however, it only served as a bridge for 30 years.

In December 1944, the retreating German troops destroyed the iron trellis construction, which had until then been the biggest span in Europe. Although the rubble was quickly removed because of Danube shipping, for half a century there was not enough political goodwill between Slovakia and Hungary to rebuild it. However, in 2000 Slovakia and Hungary, supported financially by the EU, started jointly the rebuilding of the bridge.

In 2001, the 500-m bridge was finally opened. The two countries, Hungary and Slovakia, have now created a new, strong link between them again.

"Tasty Danube"

Part 1: Fish recipes from the countries of the Danube

Every region has its special cuisine, which has developed in the course of history. Many areas of the Danube basin have a similar culinary tradition. Throughout history many recipes have been exchanged along the river, so cuisine provides a link between the many countries of the Danube basin. The recipes from the countries of the Danube illustrated at "Additional informations for teachers" show the diversity of the culinary tradition along the most international river of the world. For a long time, fish played an important role in feeding the inhabitants of the Danube and its tributaries, as is shown for example by the oldest Hungarian cookery book, preserved in the Budapest regional museum. This contains no fewer than 189 fish recipes! Even if the number of fish in the Danube has greatly declined since the end of the 19th century, not least because of over-fishing, industrial pollution and the numerous technical projects, fishing is still important in some areas.

Romania: fish soup


photo: Marylise Vigneau

Fish market: offering culinary delight.

Ingredients: 1–1.5 kg freshwater fish
2–3 onions • 1–1.5 litre water
2–3 carrots • 1 parsley root
1 parsnip • 1 small celery bulb
1–2 bay leaves • approx. 6 pepper corns
salt • pepper • 3 tbsp oil • 1 tbsp paprika
100g cream • 1 egg yolk
juice of half a lemon

Preparation:
Clean and slice the onions. Peel and cut the carrots and celery bulb lengthways, and chop the parsley. Cook at moderate heat in a large pot with bay leaves. Salt some peppercorns and cold water until the vegetables are tender. Then sieve the soup and return to the heat.

Cut the cleaned fish into large pieces and cook it in the clear soup at a moderate heat until it is done. Heat the oil, add flour and fry until light brown; add the ground paprika. Then add a little cold water and then a little soup, mix and pour it into the soup. Add salt and pepper to taste and briefly bring to the boil.

Add the diced soup vegetables to the finished soup. Before serving, whisk the egg yolk into the cream, add lemon juice and stir into the soup.

Fish soup can be eaten with croquettes or slices of white bread.

Serbia: trout with kajmak

Ingredients: a 1.5 kg trout, or 2–3 smaller ones
1 lemon • salt
200 g kajmak (or cream)
50 g wheat or maize flour
1 whole (small) clove of garlic
1/10 litre wine vinegar

Preparation:
Clean the fish, wash well, and dry and cut it into large pieces. Sprinkle with lemon juice, salt and leave for 30–40 minutes. Then melt approx. 150 g kajmak (or cream with olive oil) in the pan and fry the fish in it at a moderate temperature. Peel the garlic, press it well into the salt, dice finely and mix with wine vinegar. In a warm bowl, alternately layer the pieces of trout browned on both sides with wine vinegar and garlic. Pour over the rest of the kajmak (or cream).


photo: DRP/Victor Mello

Brown trout: the rare fish needs cold and clean water.

See at "Additional information for teachers" for recipes from other Danube countries

Suggestion: The children ask at home for special "family fish recipes" and put them in their "class collection" alongside the examples given here. If possible, the children prepare some selected dishes and mark the region they come from on the map. Are there very big differences in the recipes or are there similarities between them in the way they are prepared and the taste?

Geology of the Danube basin

2.2.

2.2. **Geology of the Danube basin**

"Rolling stones"

Geological processes did not occur only in past. They take place everywhere and all the time, and they have a decisive effect on shaping the character of a landscape.

Many of you will have collected pebbles on a river bank, been delighted by particularly beautiful or outstanding examples, and have skimmed the flat stones over the surface of the water. But where do they come from, how did they get into the Danube and where did they get their sometimes almost perfect round and smooth appearance? These are questions one does not necessarily need geological expertise to answer.

The Danube carries a mass of rock with it – gravel, sand and even finer particles – material that the Danube itself or its tributaries have taken away (eroded). Much of this never reaches the mouth of the river in the Black Sea. It is broken up, ground down on the way, dissolved in the water or laid down on the riverbed. What remains to be transported, what is taken along and what is left behind depends on many factors. The rock and mineral composition of the sediment tell us which geological zones the river has crossed and how resistant the individual elements are.

Objectives:

The children learn ...

- ✔ to recognise the diversity of stones in a river.
- ✔ to understand geological processes in a river.
- ✔ to sharpen their eye to observe differences between stones and to distinguish them.
- ✔ to understand the connection between the carrying force of a river and the size of sand and gravel.
- ✔ in playful activities to see the beauty of stones.
- ✔ to trace the geological changes in a landscape over the course of time.

Materials:

Activity 1: piece of paper with task list, buckets or tear-proof bags, a knife, pieces of broken glass

Activity 2: a selection of different stones, hammers, magnifying glasses, copper wire or copper coins, knife, pieces of broken glass

Activity 3: a selection of different stones, a typeface box or other container with compartments, drip bottles with vinegar, lists for determining hardness or rock identification book, hammers, magnifying glasses, geological map, worksheets I and II "Simple methods of distinguishing stones"

Activity 4: a shovel-load of not too fine-grain sediment from a river bank, a transparent glass or plastic cylinder closed at one end with a diameter of at least 10 cm and a height of at least 50 cm, a ruler, a marker pen, watch, worksheets I and II "Who falls by the wayside and where?"

Activity 5: a selection of different stones

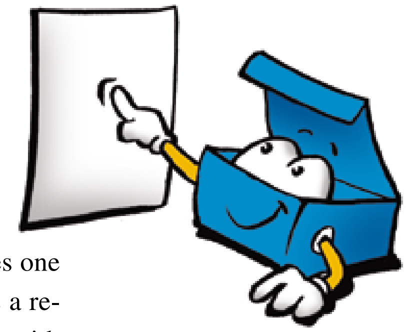
Activity 6: maps illustrating the development of the Paratethy Sea

Organisational points:

Duration: 4–5 teaching units, half a day in the open air

Location: classroom, school yard, on a stream or river with a flat shingle bank

Activity 1: Open-air activity
"We're starting a stone collection"



From experience, one knows that when one notices pretty or conspicuous stones one is unconsciously making a pre-selection. Some interesting stones are missed as a result. By allocating the tasks described below – for example, the search for stones with different features – the children also notice the unspectacular examples.

The tasks are allotted by referring to previously written notes, for example:
- stones of a particular colour
- multi-coloured stones
- striped or speckled stones
- round, flat or stick-shaped stones
- particularly strangely shaped stones
- particularly smooth or rough stones
- particularly hard or soft stones (scratch test them with a knife or piece of glass)
- human detritus (concrete, glass, bricks)

Compare the findings by discussing the following questions:
- What stones (features) occur frequently?
- Can any mutual dependency between the individual features be seen, between colour, shape and surface characteristics, form and hardness etc.?
- How many different types of stone have been found?
- Can one categorise any with similar features into groups?

Tip: Dry stones all look somewhat similar. Differences are hard to make out, so one should always determine the features of stones when they are wet. If you have built up a collection and do not want to make the stones wet every time, you can spray the surface with hairspray or colourless, soluble varnish.

Gravel, what's that?

Gravel consists of more or less rounded rock fragments from 2 mm to several centimetres in diameter, which are transported in rivers by being either rolled or pushed by the current. For further information see activity 3.

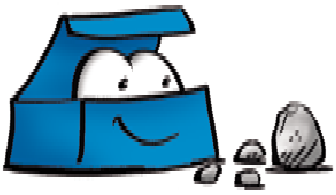
With this playful activity one gets the first impression of the diversity of stones that exist in gravel and can look more closely at the differences between small stones in further experiments (activities 2 and 3).

photo: Arno Mohl

Pebble beach: the transported material is deposited along the shore, creating a pebble beach.

Background information

Find more at "Additional information for teachers":
The formative power of water
What does the Danube transport?



Activity 2: Experiment
Only the "hard" get through

On a riverbed, gravel is incessantly tossed here and there; the stones constantly bang and rub up against each other. Some stones can stand this better than others. Some are completely worn away after a short time in the river. A simple hardness test shows the stones that have better chances of a long life in the river.

First, the children establish what sort of materials leave a clear, visible and lasting scratch on a stone (wash the scratch and if necessary check it with a magnifying glass). This proves that the stone is less hard.

Then carry out a cross check. If this is also positive, then the stones have the same degree of hardness. In most cases when stones have the same degree of hardness, however, one sees no scratches on either of them. If the stone scratches the test material, on the other hand, it is harder. Stones can also be tested among themselves. In order to produce a useable scratching edge, it is often necessary to break stones with a hammer.

When carrying out the hardness test one should make sure to test the most homogeneous and least-weathered place of the stone, otherwise one can easily get a false result (weathered stones are less hard). Sort the stones according to their hardness and arrange them in order.

Tip: With all minerals with a hardness of at least 6.5 – such as pyrites or quartz – it is possible to strike sparks with steel. These were therefore used to trigger gunpowder in old firearms. If one bangs these stones together, it is possible to make fire using suitable tinder (birch bark, straw).

Compare and discuss the findings by answering the following questions:
- What degrees of hardness are particularly common in stones?
- Which stones will survive transport in the river the longest?
- Apart from hardness, what can also be important to the way that stones resist water?

Find more at "Additional information for teachers":
Hardness identification scale

"Hard or soft"

When considering hardness one must differentiate between the clearly defined hardness of minerals and the "hardness" of a stone that arises naturally out of the hardness of its constituents. But other factors also play a role, such as porosity, grain bonding, fissility, brittleness and tendency to fracture. More important than hardness alone, it is rather the sum of characteristics that can best be described as "toughness" that is responsible for the resistance of a stone. Not all factors in a stone can be assessed with the naked eye, however.

One can find materials for testing hardness in one's own toolbox and supplement them with some easily acquired utensils. One can buy special hardness tests in mineral or teaching-material shops, for example. After carrying out this experiment, further characteristics of stones can be tested.

Background information

"Testing hardness"

Attempt to scratch individual stones with the test tools available and write the results in the table (tick where appropriate). Wash the scratch and where necessary check whether it can still be seen under a magnifying glass. Start with the knife test to separate softer from harder stones.

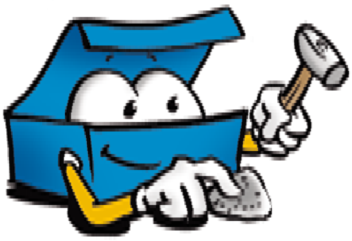
stone (brief description)	gets scratched by …								
	match-stick	finger-nail	copper wire	brass	iron nail	glass	knife	file	quartz
1	○	○	○	○	○	○	○	○	○
2	○	○	○	○	○	○	○	○	○
3	○	○	○	○	○	○	○	○	○
4	○	○	○	○	○	○	○	○	○
5	○	○	○	○	○	○	○	○	○

- Order the stones according to their hardness and make a list of them in this sequence. There may be some with the same level of hardness.

soft ⟵ ⟶ hard

- Which stone would in your opinion survive the longest in a river?

- Is every stone equally hard everywhere or do some have varying hard points? If yes to the last question, give examples and describe them.



Activity 3: Experiment
"Unexpected variety"

The stones are first differentiated and sorted according to their optical characteristics (colour, form, surface and structure).

Test the hardness of the stones or their mineral components (see Activity 2).

Test with vinegar: easily soluble stones, such as chalk, "effervesce". Small bubbles of gas form where the vinegar touches them, caused by the release of CO_2 from the calcium ($CaCO_3$). One can carry out the test with ordinary vinegar, but vinegar is a weak acid, so the reaction is less pronounced and more protracted than when for example hydrochloric acid is used.

The compartments of the typeface box are filled with stones that each have the same or similar characteristics. The stones are (as far as possible) identified on the worksheet, with the assistance of an identification book or the list "features of common Danube stones".

The following questions can be discussed in class:

- Which stones are round, oval, stick-shaped or flat, and what can the cause be? – Structures in stone, stratification, splintering.
- Which stones have smooth surfaces, and which are rough or even knobbly? – Structures in the stones, big differences in grain size, components with very different characteristics.
- Which stones are found frequently, which are rare? – Distance and size of the place of origin, selection through hardness and toughness.
- What stones are the most resistant to water and can therefore be transported a long way?
- Where may the stones have come from? – Compare with a geological map.

Tip: Geological maps can be obtained from the geological office of the respective country or from universities where geology is taught, sometimes also from bookshops. Perhaps during the purchase one may also be able to receive help with not easily identifiable stones. Visiting geological collections in museums can also help.

Find more at "Additional information for teachers":
A geological overview of the Danube basin
Features of frequently occurring river stones in the Danube basin

Stone spectrum

Every section of river in the Danube basin is distinguished by its more or less unique composition of sediment. This can most easily be observed by noting which stones exist in different areas and in what number.

The landscapes in the Danube catchment area are very different in their geological development and therefore provide a great number of stones that are typical of each region. The selection of stones through transport leads to the fact that some quickly disappear while others can hold out for longer and even increase in number downstream. Some are so unique that they can serve as lead stones for particular geological zones.

photos: Silvia Adam

Diversity: rocks, frequently occurring along the Danube.

Background information

"Simple methods of distinguishing stones" (I)

Look for various stones on a pebble beach, on a dredged-out pile of gravel or in a gravel pit and determine their characteristics. Then select one stone and answer the following questions. For this you will need a magnifying glass (with a ten times magnifying lens), a ruler, a knife, a copper coin or copper wire, and a dripper bottle with simple vinegar.

➾ How frequently did you find the stone in the area?
○ extremely rarely ○ relatively rarely ○ relatively often ○ very often

➾ What shape is it? (You can tick several fields)
○ round ○ oval ○ flat ○ stick-like ○ knobbly ○ angular

➾ What does the surface feel like?
○ very smooth ○ rather smooth ○ rather rough ○ very rough

➾ Describe the colour(s)!

____

➾ Can you see structures in the stone or does it look the same from every side?
If you can see structures in the stone, describe them.

____

➾ Can you see individual grains? Use the magnifying glass!
○ yes granular ○ no dense

➾ If yes, how big are the grains? (You can tick several fields.)
○ < 0.1 mm very fine-grained ○ 0.1-1 mm fine-grained ○ 1-3 mm medium-grained ○ 3-10 mm coarse-grained ○ > 10 mm large-grained

➾ Are all grains the same size? ○ same-sized grains

Are the grains different sizes ? ○ different-sized grains

➾ Are there individual large grains in a fine-grained base material? ○ alternating grains

➾ Does the stone consist primarily of only one type of grain? ○ yes ○ no

If not, how many different constituents can you recognise?

____

____

____

"Simple methods of distinguishing stones" (II)

➾ The stone* can be scratched with copper, it is ○ rather soft

The stone* cannot be scratched with copper but it can with a knife , it is ○ moderately hard

The stone* cannot be scratched with a knife, it is ○ very hard

➾ Does it react to vinegar? ○ yes ○ no

➾ What else did you notice?

____

____

____

____

By answering the questions you have determined important characteristics of the stone and you can now attempt to find out the name of the rock that the stone consists of. Use a rock identification book or the list "features of common Danube stones".

The rock is called:

____

____

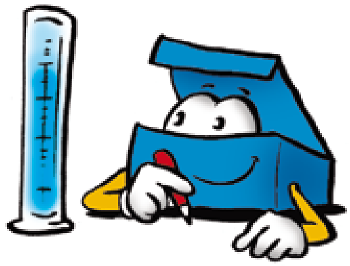
____

If you have a geological map or a geological description of your homeland you can then also attempt to find out where the stones originate from. Always search up-river!

It does not matter if you can't definitely identify the stone. Even experts sometimes don't get far with external features and have to carry out further, sometimes very complicated and time-consuming, experiments. In any case, you have seen what geologists look for and how they go about their work. And now you know how varied the world of gravel is and how much one can learn from it about what goes on under the surface of the water.

* or most of its surface

Activity 4: Experiment
"Who falls by the wayside and where?"



A simple experiment looking at the different sinking speeds of various grain sizes in water can show the force that is necessary to transport gravel, sand and clay in a river.

The cylinder is filled three-quarters full with water. Then a shovel-load of sediment is tipped in. The children observe how fast the individual constituents sink and measure the time it takes for particular grain sizes to settle. After a while, they describe the appearance of the sediment (for example, its stratification, granularity and colour). Continuing cloudiness in the column of water shows that fine particles are still in suspension, which will only settle after quite a long time. The children mark the transitions between the grain-size areas on the cylinder and determine what proportion they take up of the whole.

Summarise the measurement findings with the help of the worksheet. The experiment can be repeated with sediments from other places and the results can be compared.

Afterwards the following questions can be discussed in class:

- What does the carrying power of the river depend on? Why and at what points does it change? How long can a piece of gravel, a grain of sand or a particle of clay be carried and where do they settle? What goes into the sea at the end?
- What is carried easily in a river and for how long? What is deposited quickly?
- What do I find in "my" river? If possible, investigate the findings at a suitable place in the area.

Tip: After the experiments one can seal the other end of the cylinder and mount it on the wall so that it can be rotated. In this way one can repeat the experiment at any time.

Find more at "Additional information for teachers":
The classification of sediment according to grain size
Current speed and grain size
Erosion and accumulation

Gravel transport

The ease with which gravel is transported along a river depends on the speed of the current of the river. The smaller the grain, the more easily it can be carried.

The fine particles therefore stay in suspension for a long time, whereas the gravel is deposited (accumulated and sedimented) even if there is a limited reduction in current – for example after the widening of narrows or on gradients that gradually get shallower.

For this reason, little except fine mud finds its way into the Black Sea, whereas gravelly and sandy sediments predominate in the upper course of the Danube and stretches with a steeper gradient.

Background information

"What sinks faster?" (I)

See how fast individual constituents of a shovel-load of river sediment sink to the bottom of a cylinder filled with water. Mark the transitions between gravel, sand and other materials on the cylinder and determine their respective proportions. For this you need a ruler, a marker pen and a watch.

Grain size	Description	Time measured	Height in cm	Ratio (%)	Observations (colours, layers)
over 20 mm	coarse gravel				
2–20 mm	fine gravel				
0.2–2 mm	coarse sand				
0.06–0.2 mm	fine sand				
0.002–0.06 mm	silt				
under 0.002 mm	clay				

This can help you estimate the diameter of the grains:

- 20 mm is easy to measure with a ruler.
- 2 mm is about the width of a matchstick.
- 0.06 mm grains can still be seen with the naked eye.
- The grains in silt can only be seen using a magnifying glass.
- Anything below this only appears as a uniform, dense mass without recognisable grains.

"What sinks faster?" (II)

- Which constituent is the biggest? What proportion does it make up?

- Are particular constituents completely absent? If so, which?

- Are there differences (in colour, shape ...) between the individual constituents?

- Think about how far the individual constituents might travel with the Danube. What, for example, might have come from a neighbouring upriver country on the Danube? And what might find its way downstream into the neighbouring country along the Danube, perhaps even into the Black Sea?

Activity 5: Games
Creative games with stones

Simple games in which learning is not the main object serve to introduce children to the diversity of stones. By playing they learn to observe the features and differences more exactly and learn almost accidentally how many different types of stone there are.

Variant 1: Recognising stones

The children stand in a circle (as close together as possible) looking inwards.

Each is handed a stone and attempts to remember its characteristics. The stones are collected again.

Now the children hold their hands behind their backs and the stones are distributed again; this time the children can‘t see them in advance (possibly their eyes can first be bound with a cloth).The children attempt to find out by touch whether the stone they have now is the same stone as before. Anyone who is certain leaves the circle and waits until the end of the game. The others close the gap. If it is not the same stone, each child passes it on to the next one, and so on, until everyone has found their original stone.

When all the children finally have their original stones, the children can look at them. If children have not found their stones again, then someone has recognised the wrong stone.

Variant 2: Finding pairs

Alone or in groups the children attempt to find two almost identical stones. Then the class chooses the child who has found the best matching stones.

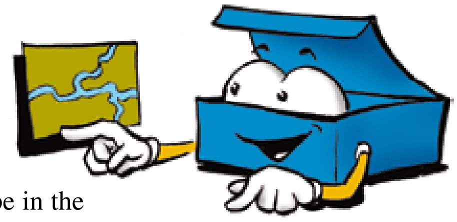
Variant 3: Making mandalas (stone pictures)

Alone or in groups the children make a picture or a figure of their choice on the floor. Mandala is the word for a far-eastern technique that is used as an aid to meditation and simply means “circle”. Usually, it symbolises the cosmos and the structure of the world in the respective culture. The form of a mandala does not have to be a circle, however, it could also be square or spiral shaped. A mandala can be a picture that is observed or produced oneself, for example by drawing a picture or symbol, through putting down stones or using different-coloured sand.

photo: primary school Sala, Slowakei

Mandala: one can paint mandalas or decorate them with stones.

Activity 6: Group work / discussion
“The making of the Danube”



On the basis of the maps, the children discuss the development of the landscape in the Danube basin and the history of the Danube.

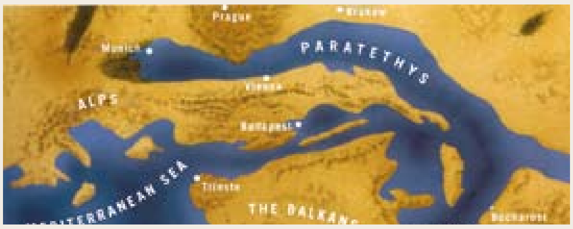
Find more at “Additional information for teachers”:

The development of the Danube **Maps for printing at: “Paratethys”**

Development of the Paratethys Sea

1: During the early Tertiary about 40 million years ago, large parts of the Alps already protruded from the sea, whereas the Carpathians were still submerged. In a large bend, the Paratethys, or Molasse Sea, stretched from the mouth of the Rhône over Lake Geneva to the Alpine foreland in Bavaria and Austria in the east. There were extensive connections between the Paratethys and the Mediterranean Sea.

4: The Molasse Sea retreats eastwards up to Vienna. Curiously, where the Danube today flows from west to east, a river was then flowing in the opposite direction: the Rhône originated in the Mostviertel Region west of St Pölten (Lower Austria) and flowed to Marseille (France) through the valleys that today are the passages of the upper Danube and the Saône.



2: Towards the end of the early Tertiary 25 million years ago, the western Molasse basin temporarily ran dry; from the east, the sea still extended to near Munich.

States Museum of Lower Austria

5: The Molasse Sea loses its connection with the Mediterranean Sea and the other seas. The forelands of the Alps and the Carpathians dry up; around 11.5 million years ago a brackish lake – Lake Pannon (Austria) – forms inside the Carpathian arc. The Danube flows northeast through Krems and Hollabrunn (Lower Austria). In the Mistelbach area (Lower Austria), it discharges into the Vienna basin, filled by Lake Pannon.

3: North of the Alps, there is still a connection between the Molasse Sea and the Mediterranean Sea at Marseille (France), running along the whole Alpine arc through the Rhône valley.

From east to west or from west to east

The second-biggest river in Europe after the Volga has a very eventful history – and, geologically considered, a very short one. Since the east–west river system formed for the first time, approximately 25 million years ago, the Danube, Rhone and Rhine (or their predecessors) have been constantly wrestling over the catchment areas of the rivers. There were times when almost all the water flowed westwards, and times when the catchment area of the Danube was bigger than it is today.

Background information

Danube tales

Solnhofen limestone slabs – Kelheim slabs

In numerous churches, monasteries and palaces there are light-yellow base plates made of Solnhofen limestone slabs, usually called "Kelheim slabs". Kelheim in Bavaria (near Regensburg in Germany) was the customs and loading station on the Danube from where large quantities of the stones were already being transported down river on ships more than 500 years ago. This 140-million-year-old limestone became famous when the "primal bird" Archaeopteryx was found. It is now mined in large quarries in the Altmühl valley in the Frankish Alb, in the area of the towns of Solnhofen and Eichstätt.

Suggestion:

The children are taken to visit churches and other historic buildings in their neighbourhood, and look to see if there are Kelheim slabs. These slabs were also used in the kitchens of old houses in the towns of the former Danube monarchy, as ovens and stoves often stood on these slabs as they were resistant to fire. If the children find a Kelheim slab, they use an atlas to follow its route from the place of origin of the slab (Kelheim) to where it is now. The children can also use the atlas to work out the approximate length of the route and consider how long such a journey might have taken. In the upper course of the Danube one can expect the river to flow at an average speed of two to three-and-half metres per second.

photo: Austria Tourism/Wiesenhofer

St Stephen's Cathedral in Vienna: Kelheim slabs were used in this famous cathedral.

photo: SEPPIA/ZINNOBER Films

Cupola from the famous memorial in Kelheim: from Kelheim the slabs were transported along the Danube and over the Black Sea to Istanbul.

Gold from the Danube

In many sections of the Danube and its tributaries the very precious metal gold can be found. The content of gold within the riverbed is always low, however, and can't be compared with other rivers, such as the Yukon in Alaska, whose rich gold content at the end of the 19th century led to a gold rush. Panning for river gold in the Danube basin has probably happened for 3,000 years, but is no longer practised today. There have not been professional gold washers since the start of the 20th century. But gold washing is increasingly popular as a leisure activity and in some places it is already a fixture in the tourist programme.

Suggestion:

On the map the children look for place and field names that indicate that gold mining has taken place there. Often these can only be found on old maps, as this activity has not taken place for a long time in most places.

It is possible to try panning for gold on gravelly, sandy river banks. Theoretically, a large, shallow bowl from the kitchen is sufficient, but a proper gold-washing pan, which one can buy in expedition equipment shops, is better. True, you will need a lot of luck to find gold, but it is also worth observing the other heavy sand components in the river with a magnifying glass or through binoculars (for example garnet, the transparent red precious stone; magnetite, an important iron ore that is attracted by magnets; or the golden glittering pyrites, so-called "fool's gold"). The most promising places to find gold are in sand or rough gravel banks.

Life under water 2.3.

2.3. **Life under water**

What river life-forms say about their river

In the course of evolution, animals and plants that live in water have adapted to a range of environmental conditions. As a result, they can use many sources of nutrients and colonise all habitats.

Physical environmental conditions for animals and plants that live in water include the speed of the current, the temperature, the oxygen content and the transparency of the water. Biological environmental conditions for them include sources of nutrients, predatory enemies and competition for shelter.

The environmental conditions for organisms in the river change over the length of the rivercourse, with the distance the water travels from the source to the mouth. As a result, there are a series of typical symbiotic communities, which are characteristic of different sections in the river system.

Objectives:

The children learn …

- ✔ that different conditions for life prevail in different sections of the river, what plants are favoured by these conditions and how this source of nutrients is used by different groups of animals.
- ✔ to determine possible animal species living in a specific section of a watercourse, the Danube, on the basis of the food available.
- ✔ to investigate the conditions for life in a stream on site and to identify the species that live there.

Materials:

Activity 1: for each group of 4–6 children: 1 set of animal cards, 1 set of food cards, worksheet "How do animals in a river feed?", a large plate, ruler; for the teacher: 1 diagram: "Types of food in the river" (all diagrams can be copied from the handbook)

Activity 2: 2 white cloths, 1 wooden pole (2 m long), tape-measure, several clipboards, paper, pencils, watch with a second-hand, a thermometer, several kitchen sieves, several shallow plastic bowls, jam jars with lids, identification books for water organisms, worksheet "Researches on the stream"

Organisational points:

Duration: 2 teaching units and half a day excursion

Location: classroom, somewhere by a watercourse

Aktion 1: Group work / discussion
Bottling, sieving, grating ...

There is a lot in a river for animals to eat and animals have developed various methods for gathering food.

In response to the introductory question, “In what form do you eat fruit and vegetables?” the children name the types of ways that fruit and vegetables can be eaten: raw and cooked, whole, in pieces, grated, pureed, as juice, and so on. The group of animals to be considered, namely river animals that feed on plants or tiny particles of dead vegetation, also ingest their food in various forms.

The children are divided into groups of 4 to 6. Each group receives a set of the cards of invertebrates (copy and cut out the cards featuring invertebrate aquatic animals – without carnivores! – from the set of animal cards in chapter 2.4.) and the worksheet “How do animals in a river feed?”. The various feeding strategies of aquatic invertebrate animals are described using the animal cards.

The children look at the cards for information about the ways the river animals feed. They fill in the results in the upper table of the worksheet “How do animals in a river feed?”. Then each group is given a set of food cards (to be copied from page 65 and 66).

On the diagram “Types of food in the river“ (on page 62) the relevant type of watercourse or the correct section of the river is selected for a stream or river near the school, for example the Danube. In the appropriate section on the diagram, a vertical line is drawn, which passes through the areas of various food sources and feeding types. The length of the line within such an area corresponds to the proportion of this food source relative to the total amount of food in this river section or type of watercourse.

The children determine the appropriate food sources in their river section or watercourse by using a ruler to measure the length of the line passing through the areas with the different food types.

The children choose the appropriate feeding cards and put between one and four cards on the plate, depending on the relative frequency of the food sources and feeding types: one card for the least common and four cards for the most common feeding type. If a feeding type does not occur in the chosen river section or watercourse, no card is placed.

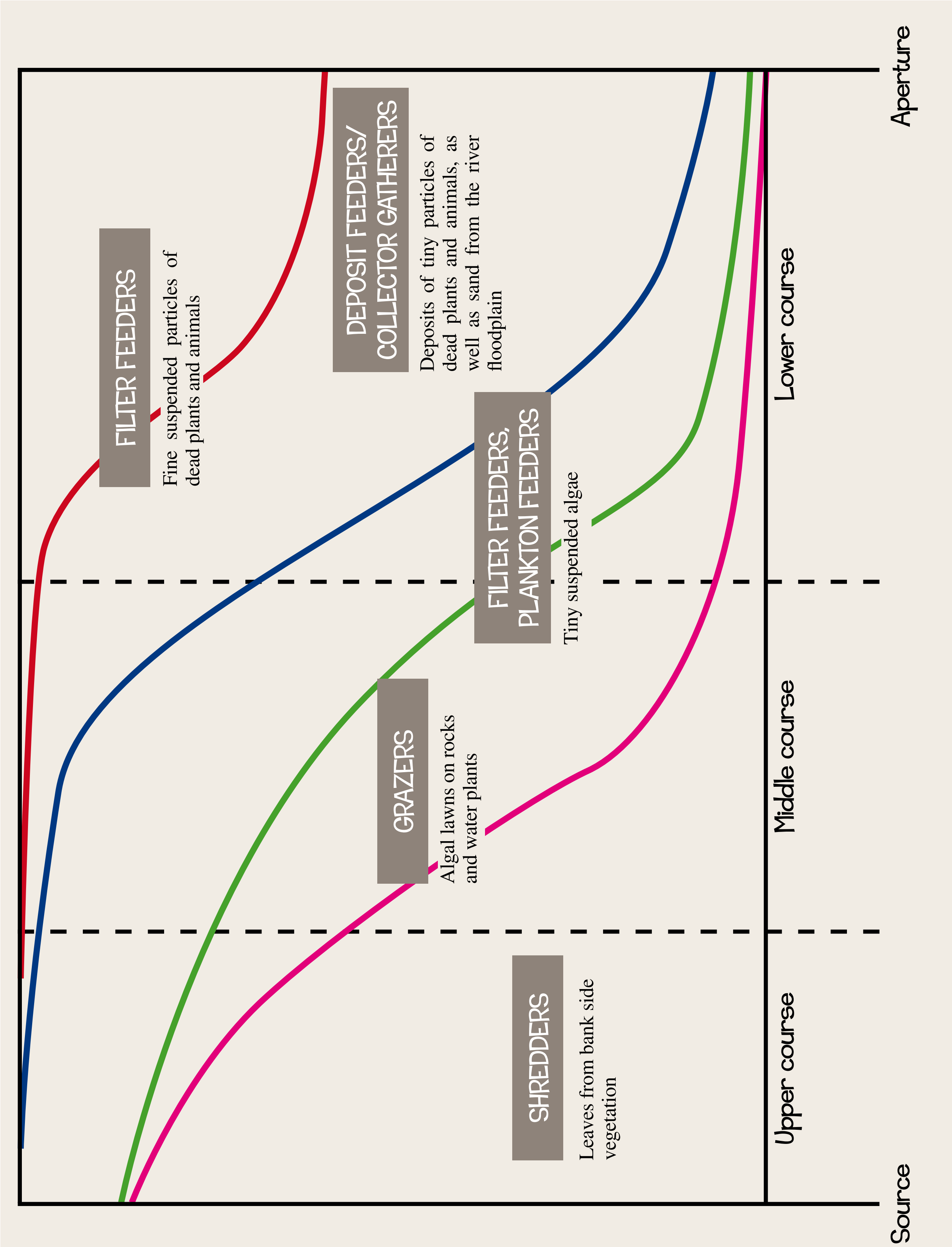
An example: Leaves from bank-side plants, 4 cards; lawns of algae, 3 cards; tiny suspended particles of plants and animals, 2 cards; deposits of tiny particles of plants and animals, 1 card. The pupils enter the results in the lower table in the worksheet “How do animals in a river feed?” and thus get an overview of the frequency of the different sources of food and feeding types in the chosen sections of river or water bodies.

Tip: In order to draw attention to the fact that different food resources are available in other sections of the river, a second line can be drawn in a different section on the diagram. The children can analyse it as described above.

The reasons for the occurrence of these types of foods in this particular river section are explained.

Feeding types in the river course

The figure shows the different feeding types of invertebrate herbivores in the Danube. Sources of food are attached and suspended plants and other particles transported in the river. The area between the curves shows the relative occurrence of these food sources in the upper course, middle course and lower course. Animals that have similar methods of gathering food exploit similar food resources.



How do animals in a river feed?

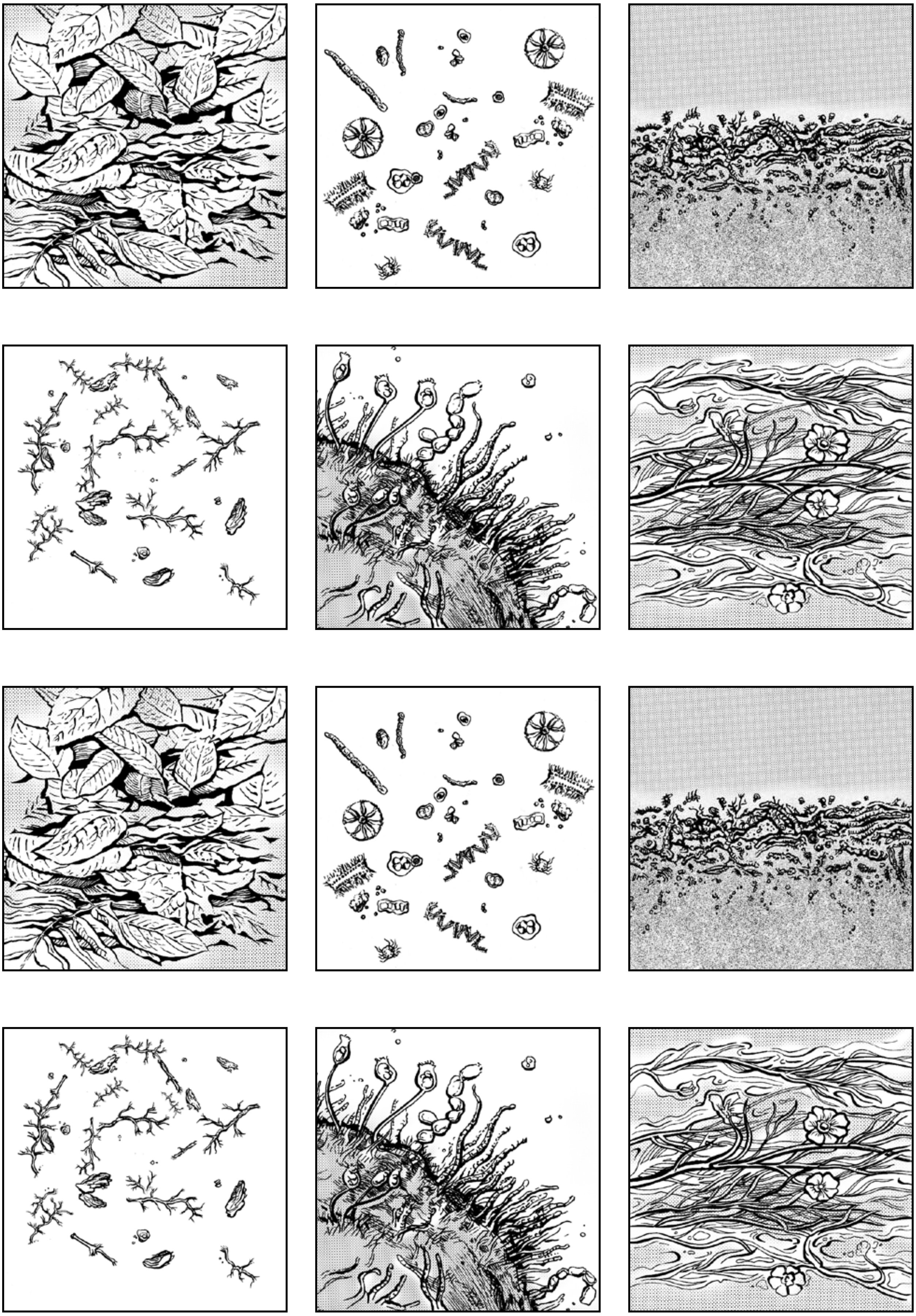
There are all sorts of things in a river for aquatic animals to eat, and they have developed various methods of getting their food.

➭ Enter what you have found out about how aquatic animals feed in the following table:

Animal	Food	Feeding type

➭ Enter in the table the section of river or the water body, the source of food and the number of cards.

Section of river or water body	Source of food	Number of cards



Food cards

Tiny particles of dead animals and plants that have fallen to the ground. Together with fine soil particles they form a dark sludge.

Tiny, fine suspended algae. They can develop only where there is little current.

Fallen leaves from bankside vegetation, easy to break down.

Water plants, grow in clear water and provide a habitat for small algae.

Lawns of tiny algae and animals. Grow wherever possible in clear water where sunlight penetrates.

Tiny particles of dead vegetation floating in the water. They are overgrown with bacteria.

Tiny particles of dead animals and plants that have fallen to the ground. Together with fine soil particles they form a dark sludge.

Tiny, fine suspended algae. They can develop only where there is little current.

Fallen leaves from bankside vegetation, easy to break down.

Water plants, grow in clear water and provide a habitat for small algae.

Lawns of tiny algae and animals. Grow wherever possible in clear water where sunlight penetrates.

Tiny particles of dead vegetation floating in the water. They are overgrown with bacteria.

Food cards

Activity 2: Outdoors
Researches on the stream

There is a lot to see and discover in a stream. By spending half a day outdoors by a stream, the children can put the theoretical knowledge they have gained from working through this chapter into practice.

The teachers look for a safe place on a stream with near-natural surroundings that has varied banks, changing currents and clean water. They have a collection of interesting objects, which serves to awake curiosity and to encourage quiet, concentrated work among the children. Activities 2 to 5 are intended to demonstrate the existence of different environmental factors, which are also reflected in the range of species in Activity 6. The research activities can be carried out in a modified form on the bank of a river.

Part 1: The great search

In small groups, the children go in search of interesting objects. They are given the following instructions:

Find:
- 5 different stones
- 5 different signs of animals, for example snail shells or caddis fly cases
- 5 different leaves of bank-side or water plants
- pieces of driftwood
- traces of humans, for example cigarette stubs.

Each group presents their findings on a white cloth; afterwards possible origins of the collected objects are discussed and explained.

Part 2: Measuring the size of stones

A 2-m-long wooden pole is laid out on a non-vegetated area of the river bank. In groups of three, the children measure the stones lying adjacent to the pole: one child picks up the stone, another measures its size with a tape-measure, the third ticks the size category from a list of options, e.g.:

10–5 cm, 5–4 cm, 4–3 cm, 3–2 cm, 2–1 cm, <1 cm

The number of stones on the riverbed within each size category can be depicted on a simple bar chart.

Part 3: Mapping bank structure

In pairs, children sit on opposite banks, and each sketches what the edge of the bank looks like over a length of 10 metres, marking the bank's structure such as steep and shallow sections, undermined sections, stones, roots, trees, and so on.

Part 4: Measuring current speed

Measure a stretch of 2 metres with a tape measure and mark it with a wooden post at each end. Throw a piece of wood as far as you can into the middle of the stream, and measure the time it takes to pass from the first to the second post. Repeat the process on the left and the right banks of the stream.

Part 5: Measuring water temperature

The children choose a place to measure the water temperature.

Three children put their hands in the water and guess the temperature. Someone notes down what they say.

Then a thermometer is lowered into the water on a string, tied to a stone, and left in the water for 10 minutes in a position where there is little current. The temperature is recorded.

Part 6: Stream dipping

There are several ways of doing this:

a) Turn over stones on the stream bed, carefully flush off animals with a sponge and wait for them to be driven into a sieve by the current (in a mountain stream).

b) Carefully brush off animals from water plants with your fingers and allow them to float into the net or sieve.

c) Take a bucket of sand or gravel from the riverbed and put one handful after another under running water in a plastic vessel, so that the inhabitants of the riverbed are washed into the sieve by the current.

d) Put the animals in plastic containers according to their taxonomic group and identify them using an identification book. Write your findings on a worksheet. Keep the animals in the containers only as long as is necessary and after they have been identified return them carefully to the stream.

To conclude, the measurements are entered on the record sheet "Researches on the stream". In school, the effects of individual factors on the way that animals feed and the way that individual taxonomic groups of animals adapt to their forms of nutrients are discussed.

Find more at "Additional information for teachers":
Environmental conditions
Water movement and adaptations of organisms

"Researches on the Stream"

When carrying out a research project it is important to document carefully all observations that are made.

Record sheet

Date:

Time:

Name of the stream:

Location:

The research was carried out approx. ______ m from ____________

Bank surroundings: ○ deciduous woodland ○ mixed woodland ○ coniferous woodland ○ meadows ○ farmland

Bank: ○ natural ○ artificial ○ shingle bank ○ concrete

Nature of the riverbed: ○ stony ○ sandy

Width of stream: __________ m

Water depth: _____________ m

Water temperature: _______ °C

Current speed: ________ m/s ___________ km/h

Species:

Find more at "Additional information for teachers": Zoning of rivers according to the leading species

The different sections of a river

The upper course

In its upper course the river is still so narrow that it is barely more than a stream. The crowns of the bank-side trees form a dense roof over the water. The main source of plant food are fallen leaves from the bank-side trees. Where the stream gets bigger and light reaches the waterbed, a carpet of diatom algae and green algae forms on stones and dead wood, which is eaten by grazers. The predominant feeding forms are shredders (invertebrate detritivores), which digest the leaf mass, and various grazers (or scrapers), which feed on algal growth. Most of the leaf is broken down by the current, bacteria and mould, and transported downstream.

The middle course

The river becomes wider. The riverbed now receives enough light. In clean water, many aquatic plants are able to grow. Rocks and water plants become covered in unicellular diatoms and green algae. These are the main food source for the grazers, which are the predominant feeding form in the middle course of the river. The water plants themselves are eaten by only a few animals. Leaf fall from the bank-side trees, the food source for shredders, is lower than in the upper course of the river.

On the previous stretch of the stream, in the meantime, some dead organic material has collected. The first filter-feeders appear. They live on these fine particles, known as detritus.

The lower course

The gradient becomes shallower, and thus the speed of the current of the river becomes slower, the sediments carried become ever finer, and the water turns more turbid. The coarser organic particles that have been carried with the river sink to the bottom in bays and side-arms. Mixed with mineral sediment, they form the ground sludge, the food source for the sludge eater. The fine particles that remain in suspension are eaten by the filter feeders. As the organic particles increase downstream, they represent the most important food source in the lower course of the river.

The development of water plants and lawns of algae is reduced in turbid water. The low current speed, however, creates favourable conditions for the development of tiny floating algae, plant plankton (or phytoplankton).

The floating plankton feeders (animal plankton or zooplankton) and the filter feeders eat them.

The delta

Immediately before it joins the sea, the river has reached the shallowest gradient of its whole course. Most of the accumulated organic particles have sunk to the bed of the river or have been decomposed into nutrients by bacteria, which favours the growth of large quantities of plant plankton. The predominant feeding forms are sludge eaters and plankton feeders.

Sludge eaters and plankton feeders form the food base for the enormous abundance of fish in the Danube delta. The innumerable species of birds in the Danube delta also live on this rich food source.

Background information

Find more at "Additional information for teachers":
Lead species for individual sections of the Danube

Feeding forms of small invertebrate animals in water

Shredders

Shredders are small crustaceans that feed on fallen leaves. In order to extract nutrients from the leaves, they break the larger pieces down into smaller pieces. The scraps from their feeding are further broken down by bacteria. They also play an important role as a source of food for fish.

Examples:

freshwater shrimps, water hoglouse (water slaters)

Grazers

Sunlight hitting stones, pieces of wood and water plants makes it possible for tiny algae (diatoms and green algae) to grow on these surfaces. Water plants offer a large surface area for algal growth, as they usually have finely separated leaves. Grazers have specialised mouth parts, such as the rasping tongue of the snail, to feed on this algal growth.

Examples:

stonefly larvae, mayfly larvae, caddis-fly larvae, freshwater limpets, great pond snails

Filter feeders

Large quantities of finely disintegrated particles of dead plants (detritus) are kept in suspension by the river current. They are often overgrown with bacteria, which represent the actual food source for many filter-feeders. Filter feeders originate from leaves from bank-side trees in the upper course and from the floodplain forests along the river, from which a large amount of plant material is flushed out during flooding. A second food source for filter feeders in the lower course is the floating single-celled algae (plant plankton).

Examples:

painter's mussels, moss animals (Bryzoans), freshwater sponges, rotifers, blackfly larvae, mosquito larvae

Plankton feeders (animal plankton)

In the slow current of the lower course of rivers grow small, floating, single-celled algae, similar to those in standing water.

They form the food base for floating animal plankton, usually small crustaceans, and for some highly specialised fish species such as the blue bream and juveniles of pontic shad.

Examples:

water flea, freshwater copeopods, rotifers

Sludge eaters

Sludge eaters dig tunnels in the sludge and swirl it up through their own movements. Besides sunken soil particles, sludge also contains finely decayed particles of dead plants (detritus), which these animals eat. They often exist together in large numbers and can cope with heavily polluted water.

Examples

midge-fly larvae, sludge worms, some mayfly larvae

Carnivores

Carnivores use the rich food supply of other invertebrate animals. They are represented equally in all sections of the river.

Examples:

flatworms, leeches, stonefly larvae, great silver water beetle larvae, dragonfly larvae, water boatmen

Background information

Danube tales

Bridges, ferries and fords – the connection of the two banks of the Danube

The Danube has always been an obstacle to the migratory movement of people, but not an impassable one. There were always narrow places in the upper course, as well as places in the upper and middle course where although the river was wide it was also shallow and so it was sometimes possible for traffic to cross the river through fords.

There have been ferries and even boat bridges for a long time. From early on, however, there were bridges on the Danube in order to enable large numbers of people to cross the river and difficult stretches of the river quickly, because they were deep and fast-flowing. Today there are hundreds of bridges across the Danube from the source to the mouth. In Vienna alone there are 17 Danube crossings; in Budapest there are nine. However, once one has crossed the bridge at the Iron Gate, at Drobeta (Turnu Severin) in Romania, then apart from ferry links there is no other crossing of the Danube for hundreds of kilometres.

Between Romania and Bulgaria there is only one bridge in a stretch of 500 km, between the cities of Giurgiu and Ruse. This was built in the 1950s and is called Friendship Bridge. In the lower course of the Danube, the way the river draws the border is particularly clear.

Romain bridges

The emperor Trajan built the first fixed bridge over the Danube, at Drobeta (Turnu Severin) on the Iron Gate. As early as AD 105 he marched across the river on the 1,070-m-long wooden bridge, which had 20 stone pillars. It was demolished by the Romans themselves in 271–2, when they were forced to withdraw from the Roman province of Dacia and wanted to prevent the enemy invading.

The second fixed stone bridge was built on the orders of the Emperor Constantine in 328–9, some 20 km west of the mouth of the Olt. It was 1,150 m long and was a symbol shown on several imperial coins. Again, it is likely that the Romans destroyed the bridge themselves, before 376, in order to make it more difficult for hostile people to cross the Danube. In the course of history, temporary pontoon bridges (many boats tied together with wooden planks across them) were sometimes built, particularly for military offensives. In this way large numbers of people could cross the river in a short space of time.

photo: Milena Dimitrova

Stone bridge in Bulgaria: crossing the Osam near Obnova.

Bridges of the Middle Ages

Between 1135 and 1146 the oldest remaining and functioning bridge over the Danube, the Regensburg Reichsbrücke, was built. The con-

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photo: SEPPIA/ZINNOBER Films

Bridge in Regensburg/ Germany: the oldest still passable bridge on the Danube.

tractor was Duke Heinrich the Proud, although it was paid for by the rich merchants of Regensburg who owed their wealth to long-distance trade. It is 350 m long.

In the Middle Ages numerous wooden bridges were built and ferries were used to make river crossings wherever possible.

In the middle of the 19th century, between Passau and the Black Sea there were some provisional wooden and pontoon bridges (which had to be repaired repeatedly after being damaged by ice or flooding), but there was not one permanent bridge crossing. The chain bridge (Széchenyi Lánchíd) in Budapest, built between 1839 and 1849, was the first fixed Danube bridge of the Austro-Hungarian monarchy and connected the two cities of Buda and Pest, which was essential for the development of Budapest. It was blown up at the end of the Second World War, but later re-opened in 1949, exactly 100 years after it was first built.

Until shortly before 1900 there were no bridges in the lower third of the Danube and it was only possible to cross the river by using a ferry or, in winter, on foot when it was frozen.

This changed with the massive project to build a railway bridge at Cernavodă to Fetesti in Romania, which was opened in 1895. This spans the Danube in an area that includes two river arms and marshland. The bridge is 15 km long.

photo: Bogodan Giusca

The double bridge from Cernavodă: for car and railway traffic between Romania and Bulgaria.

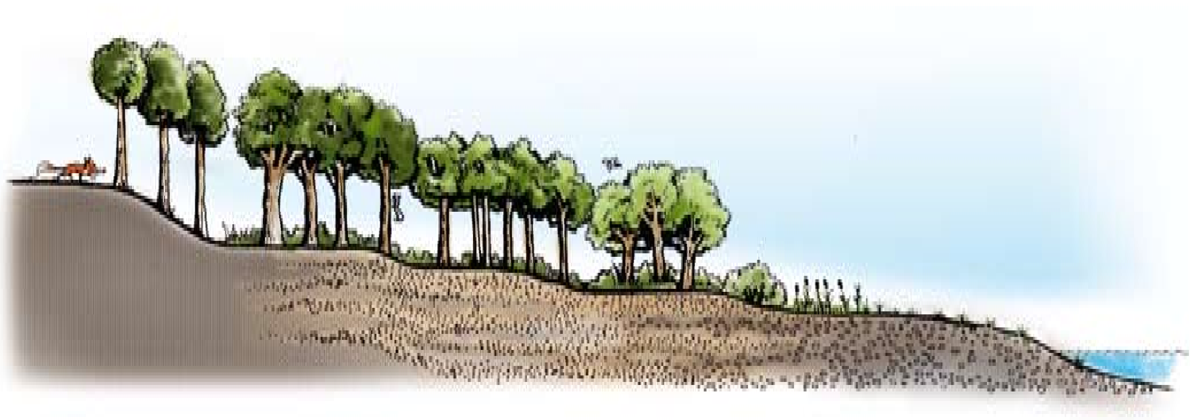
Habitats of the floodplain forest

2.4.

2.4. **Habitats of the floodplain forest**

The diversity of water worlds

A river is more than just water in a riverbed. The landscape to the left and right of the bank, shaped by flooding, is called the floodplain or riverine forest. Its outer border is formed by the areas that are just flooded during severe flooding. The width of the flood-plains ranges from less than 100 metres in the highlands to 20 kilometres on the lower Danube in Romania.



Succession: the frequency of flooding determines the way that plants cover the flood-plains (peak flooding occurs every 10–30 years). The further away from the river, the finer are the sediments that are deposited in the floodplain.

A river in its natural state changes its course with every major flooding. Parts of the banks can be washed away and deposited elsewhere as islands and shallow banks. When there is severe flooding, the river can cut new channels. Whole river bends are cut off and may change into oxbow lakes with standing water. The annual flooding that causes river banks and waterways to change creates a great diversity of habitats.

Objectives:

The children learn ...

✔ to recognise important habitats along rivers and the fauna and flora that are typical for them.

✔ to recognise what habitat animals and plants live in and to determine the position of the habitats in the course of rivers.

Materials:

Activity 1: copies and possibly overhead transparencies with pictures of typical habitats, fauna and flora cards to copy and cut out, Danube poster, sticky tape, worksheet "Habitats of the floodplains"

Organisational points:

Duration: 2 teaching units

Location: classroom

Activity 1: Group work / discussion
How many "house numbers" does a river have?

The habitats along a large river have different living conditions for animal and plant species.

Copy the 24 fauna and flora cards from the copy model double sided and cut them out (depending on class size, copy some cards twice).

Lay out the fauna cards face down on the table and ask the children to draw one card each.

Draw the following table on the blackboard, copy the matching habitat pictures and hang them next to the row with the habitats in the table.

The children should now categorise the animal and plant species that they have drawn for a habitat, then enter the name of the animals and plants in the table. On the reverse side of the copied flora and fauna cards there is also information about the characteristics of the plants and animals. This is then noted in the table as key words. In this way the children get an overview of the different animals and plants in the various habitats.

Habitat	River arm with gravel bank	Floodplain with oxbow lake I and II	Reed bed	Pond with floating plants
Fauna and flora				
Characteristics				

All the children with cards that have characteristics from the same habitat go together in one group. Each group is given the habitat picture in the second version habitat pictures (with gaps and a true-to-scale section of the Danube) copied on an overhead transparency. With the aid of the text on the back of the cards the children should now be able to stick their animal in the right place.

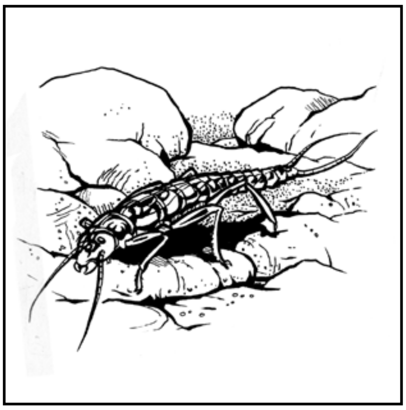
In the group, the children put the overhead transparency on the poster of the Danube. The group should then enter the name of the river section (see chapter 2.1.) on the table. With the information from the table each child repeats the tasks from the worksheet.

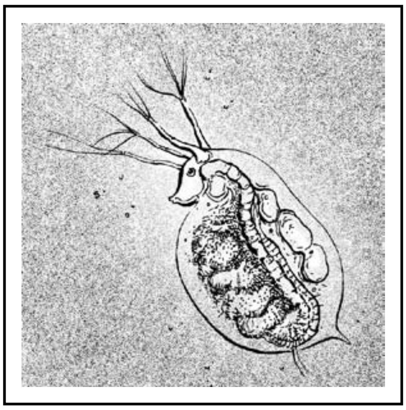
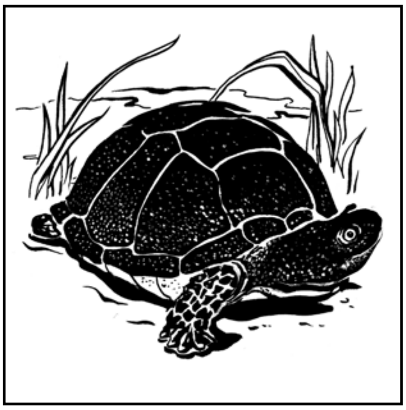
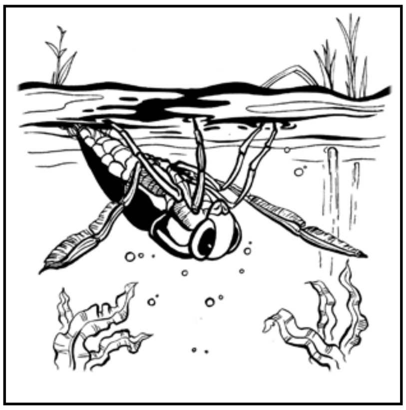
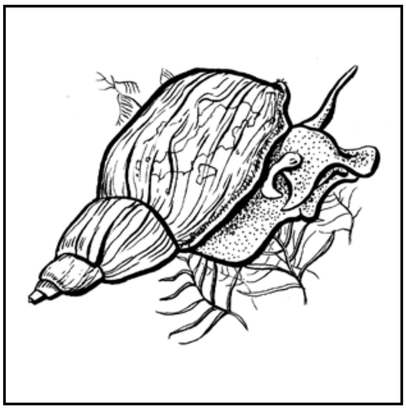
The children transfer information from the tables onto the worksheet and complete the portrait of their plant or animal underneath. This can be a painting of their animal (pictures from identification books are helpful) or a description taken from the information in the flora and fauna list. A description of all the flora and fauna on the habitat pictures can be found in the article "Lead species of the habitats" at "Additional informations for teachers".

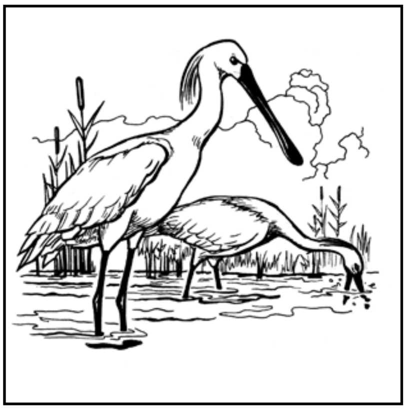
Find more at "Additional information for teachers": Lead species of the habitats

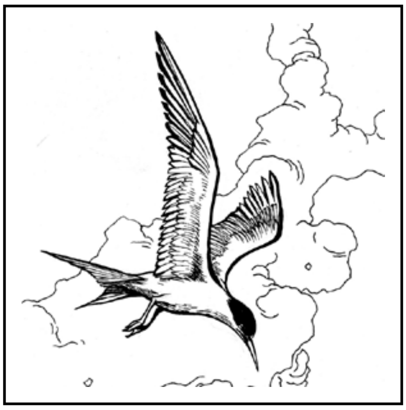
Overview over the characteristics of different river sections, taking the Danube as an example

Section of the river	Upper course	Middle course	Lower course	Delta
Average river gradient (altitude difference [m] on a stretch of 1 km)	>1 m per 1,000 m	56 cm per 1,000 m	6 cm per 1,000 m	< 1 cm per 1,000 m
Material of the riverbed	Boulders, stones, gravel ø: > 13 mm	Gravel, sand ø: 0,2 mm - 20 mm	Sand ø: 0,2 mm - 0,85 mm	Sand, silt ø: 0,02 mm - 0,85 mm
Form of the river	Typically straight	Meandering, ramified	Winding, meandering	Split into branches
River width	Up to 3 m	Flood plain up to 3 km	Flood plain up to 20 km	Delta 70 km
Geological processes	Vertical erosion	Vertical erosion and sedimentation, some lateral erosion	Sedimentation, lateral erosion	Sedimentation
Route	From the headstreams Breg and Brigach to Sigmaringen	From Sigmaringen to the confluence with the Raab	From the confluence with the Raab to the beginning of the Danube Delta	Danube Delta




Fauna and flora cards for copying

I live in fast-flowing rivers.
I am a shredder and eat
leaves that fall into the water.
(freshwater shrimp)

2

There are lots of trees and
bushes in my habitat that
I can climb around on.
(tree frog)

5

I have six legs and live in
fast-flowing rivers under stones
or pieces of wood.
I am a grazer and nibble algae
and bacteria off the stones.
(stonefly larva)

1

I am a grazer and my
favourite food is the algae
that grow on floating leaves
and water plants.
(great pond snail)

3

I am a carnivore and swim
past lots of reeds in search
of animals.
(water boatman)

1

There are a lot of trees in my
habitat, so I can easily find a
fallen tree to sunbathe on.
(European pond turtle)

6

I breed in the reeds and
when I eat I most like to strain
through the mud in
open stretches of water.
(spoonbill)

7

I am a plant that grows very
fast and strong. My stalks
grow up to 3 metres high.
(reed)

10

I live on a river with a gravel
bed and build a case out of
pieces of wood. I am a grazer
so I eat algae and bacteria.
(caddis-fly larva)

3

To breed, I like to have a
place from which I can see
everything, like a bare shingle
island with no plants on it.
(common tern)

7

After catching fish I
always need a tree to
sit on and hang my
wings out to dry.
(cormorant)

7

I most like to paddle
through my pond
and eat insects.
(pond frog)

7

I live in a pond with
quiet water and go in
search of food at night.
(catfish)

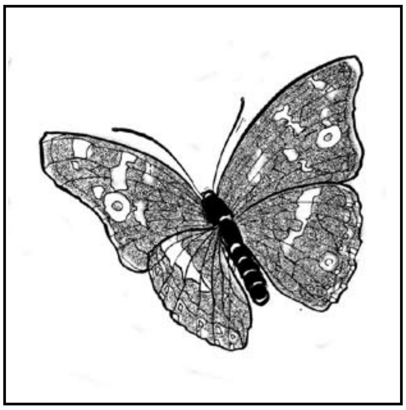
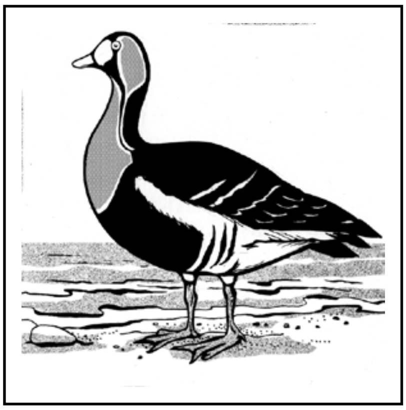
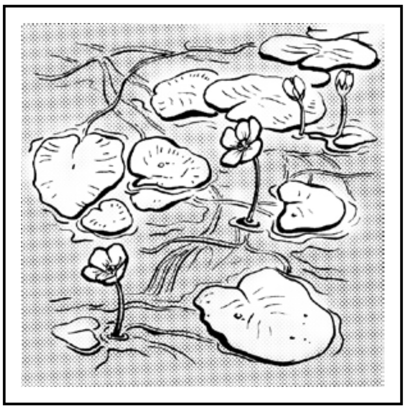
5

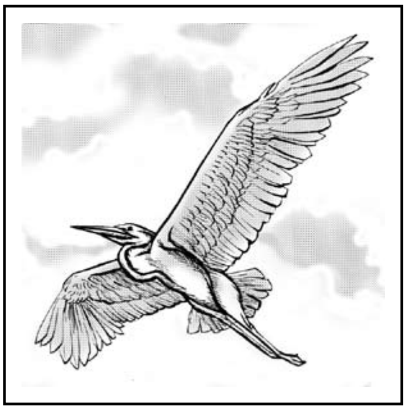
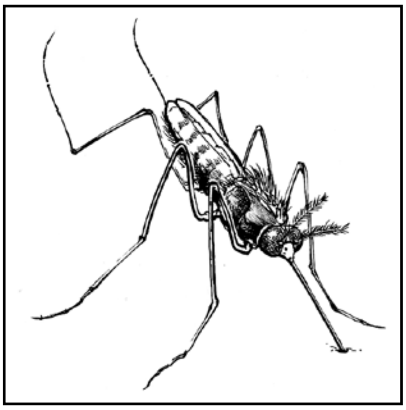
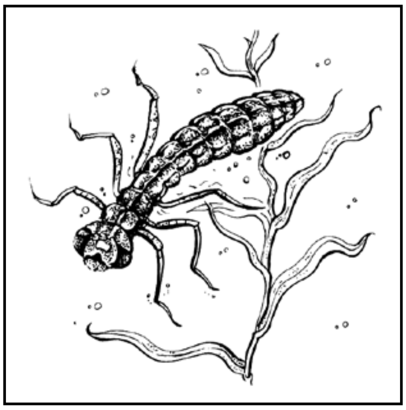
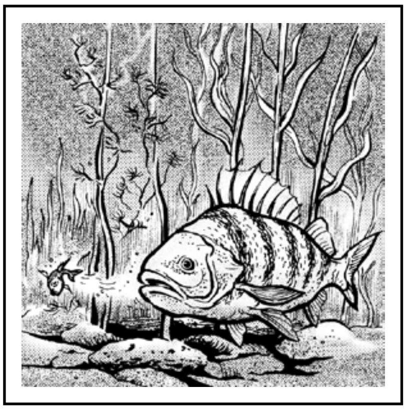
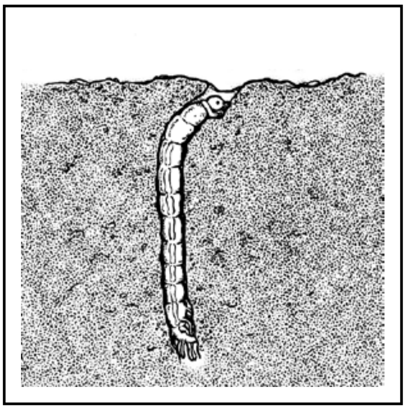
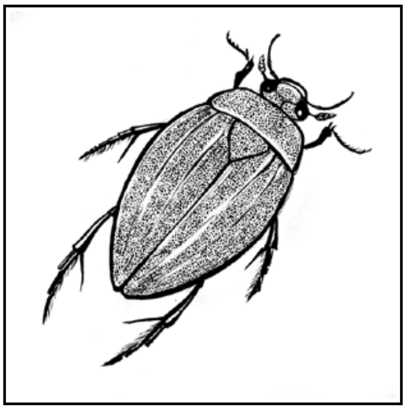
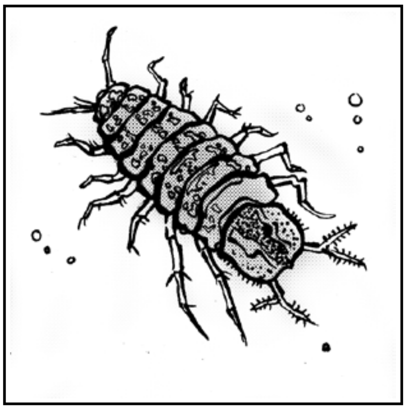
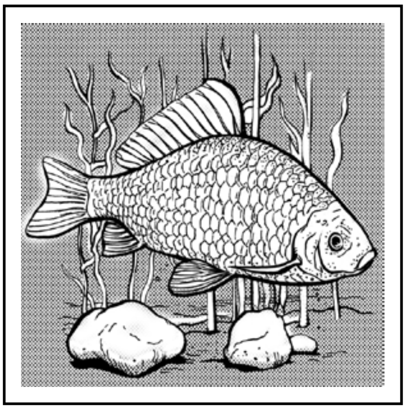
If there are enough trees
where I live, I can build my
hidden nest and fish on quiet
arms of the river.
(black stork)

16

I am a filter-feeder in muddy
riverbeds. My food is tiny parts of
dead animals, plants and algae
floating in the water.
(painter’s mussel)

2

Fauna and flora cards for copying

I am a very colourful
bird and spend the winter
on ponds and open
areas of water.
(red-breasted goose)

10

My caterpillars eat the leaves
of willows while I often
come down to the water to drink.
(Freyer's purple emperor)

13

To grow under water
I need food from the water
that is slowly flowing past me.
(watermilfoil)

9

I most like to breed together with
other members of my species in
trees near the river. We make a lot
of noise about it.
(grey heron)

17

I am a big tree growing on the
floodplain forest. Many birds
breed in my branches. My leaves
whiten in the wind.
(white willow)

10

I like to grow in shallow ponds
that are in the sun, so that the
water warms up quickly.
(fringed water lily)

12

I hunt my prey together with
other members of my species
in quietly flowing water
between water plants.
(Aral bream)

14

As an adult animal, I fly around
like a helicopter, but in my youth I
am a carnivore in a quiet body of
water in the floodplain forest.
(dragonfly larva)

12

Our parents lay their eggs in
damp places in the floodplain
forest. We are filter-feeders and
live on floating particles of dead
animals or plants.
(mosquito)

11

In spring I float in the water of
ponds and big rivers. As a
plankton-eater, I pick up
algae out of the water.
(water flea)

2

My larva is a carnivore that
feeds on snails that live on
water plants.
(great silver water beetle)

2

I hide in the muddy ground at
the bottom of a pond. As a
sludge-eater, I burrow for particles
of dead animals or plants.
(midge-fly larva)

1

If I want to have babies I need
shallow gravel banks with
water running over them
in order to spawn.
(grayling)

4

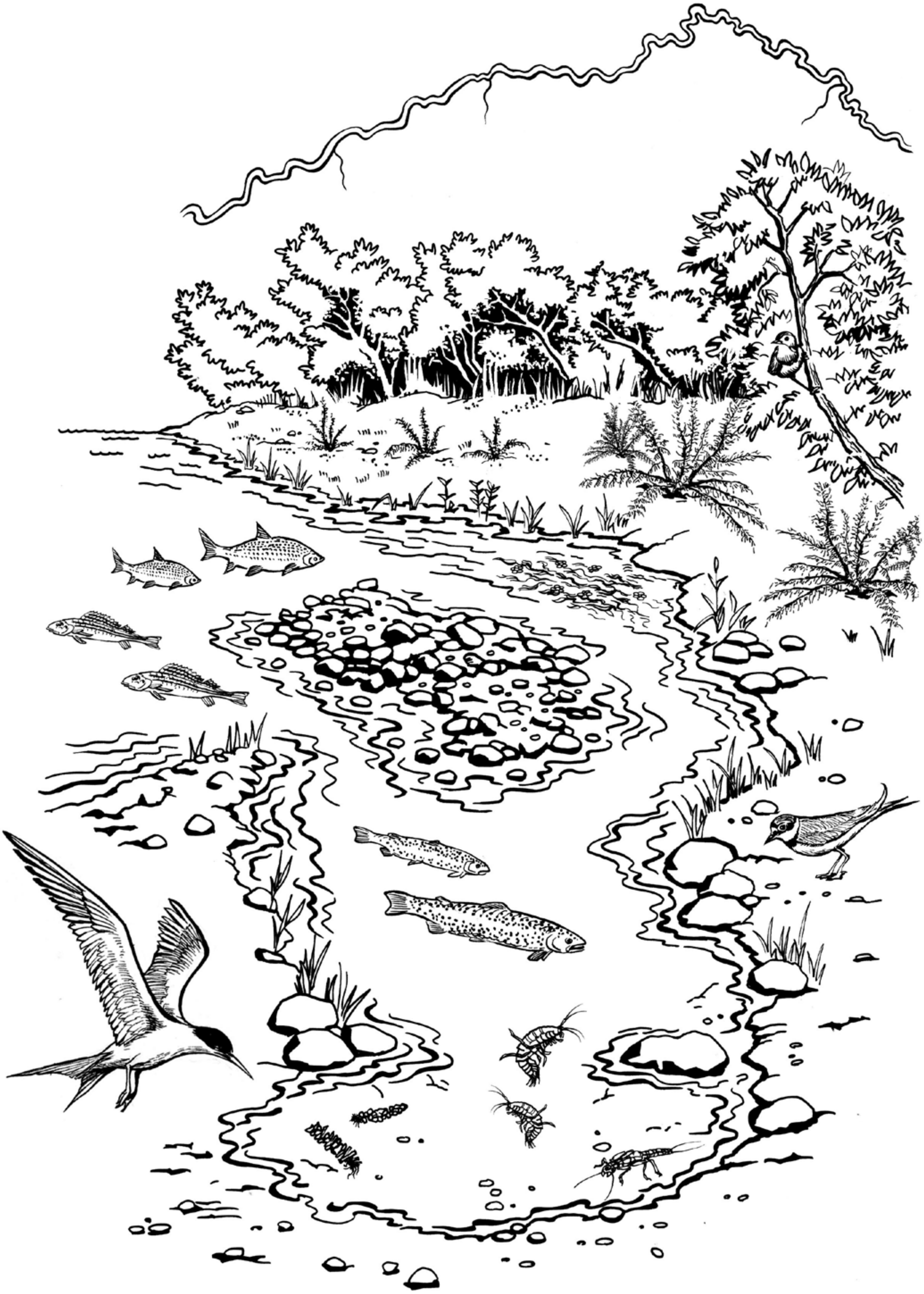
I use my big beak to catch
the many fish I need for my
young from the pond.
(pelican)

11

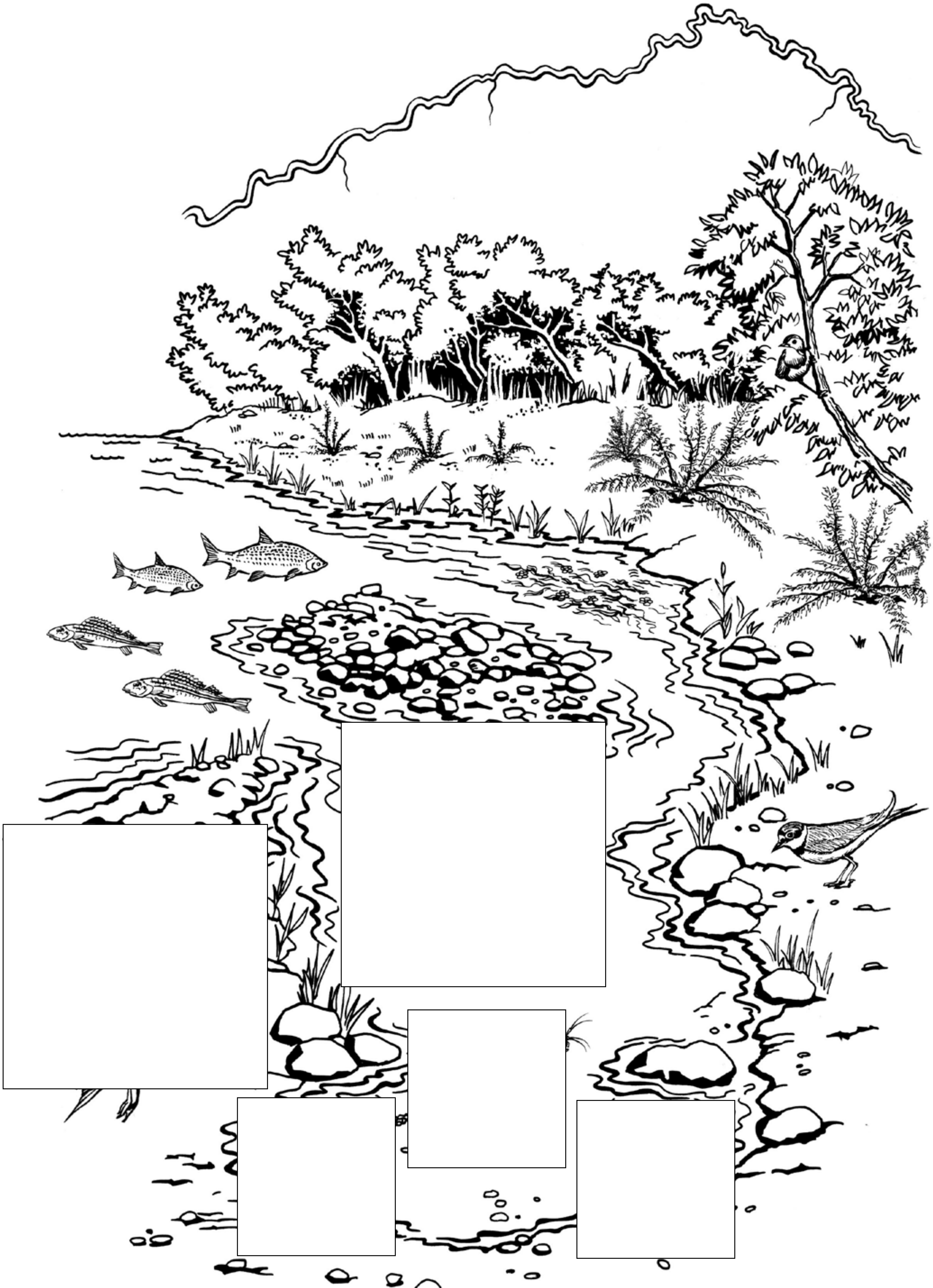
When the water between
the reed stalks gets shallower
and shallower in summer,
I can still cope.
(crucian carp)

4

Habitat "River arm with gravel island"

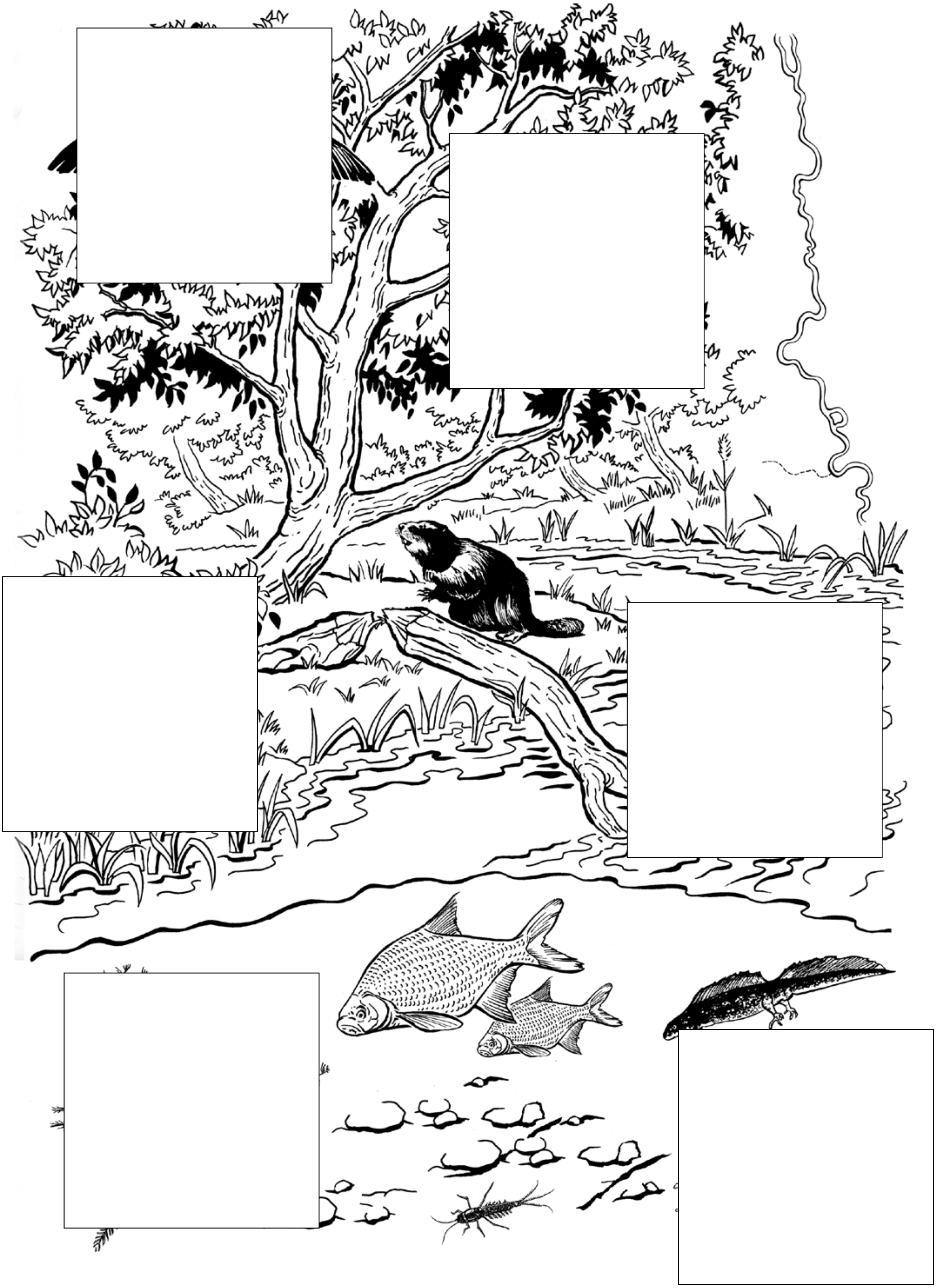


Habitat "River arm with gravel island"



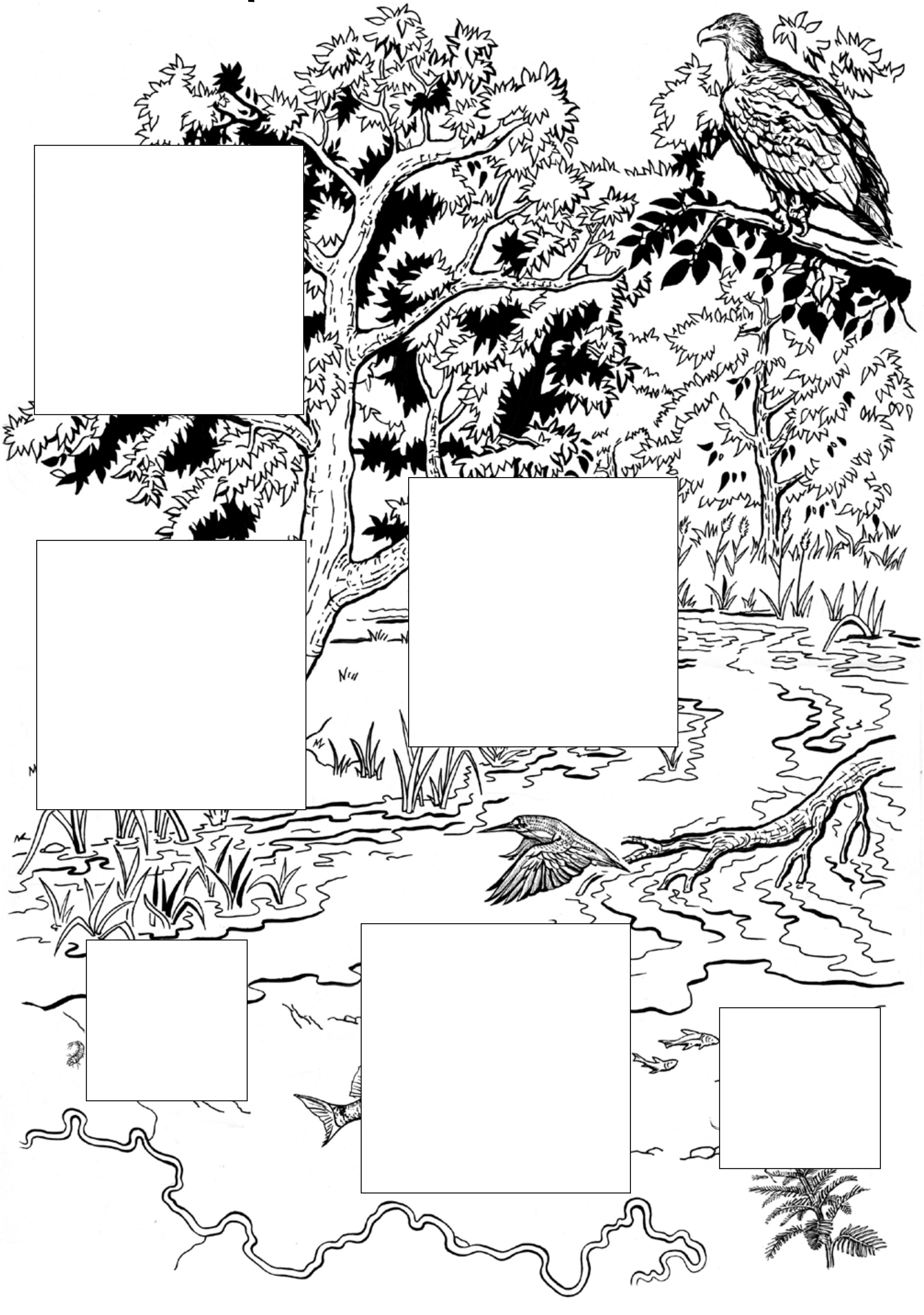
Habitat "Floodplain forest (I)"

Habitat "Floodplain forest (I)"



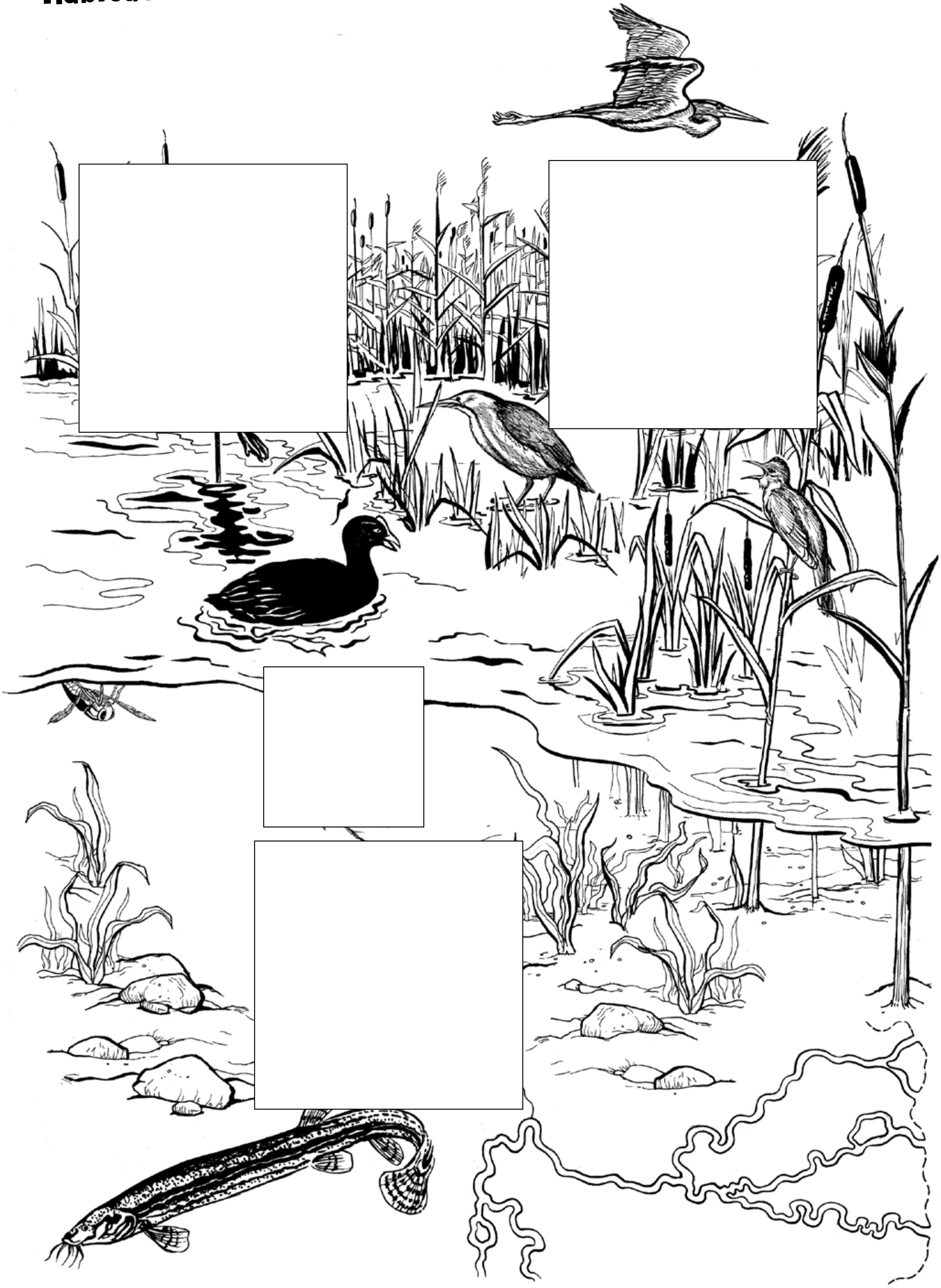
Habitat "Floodplain forest (II)"

Habitat "Floodplain forest (II)"

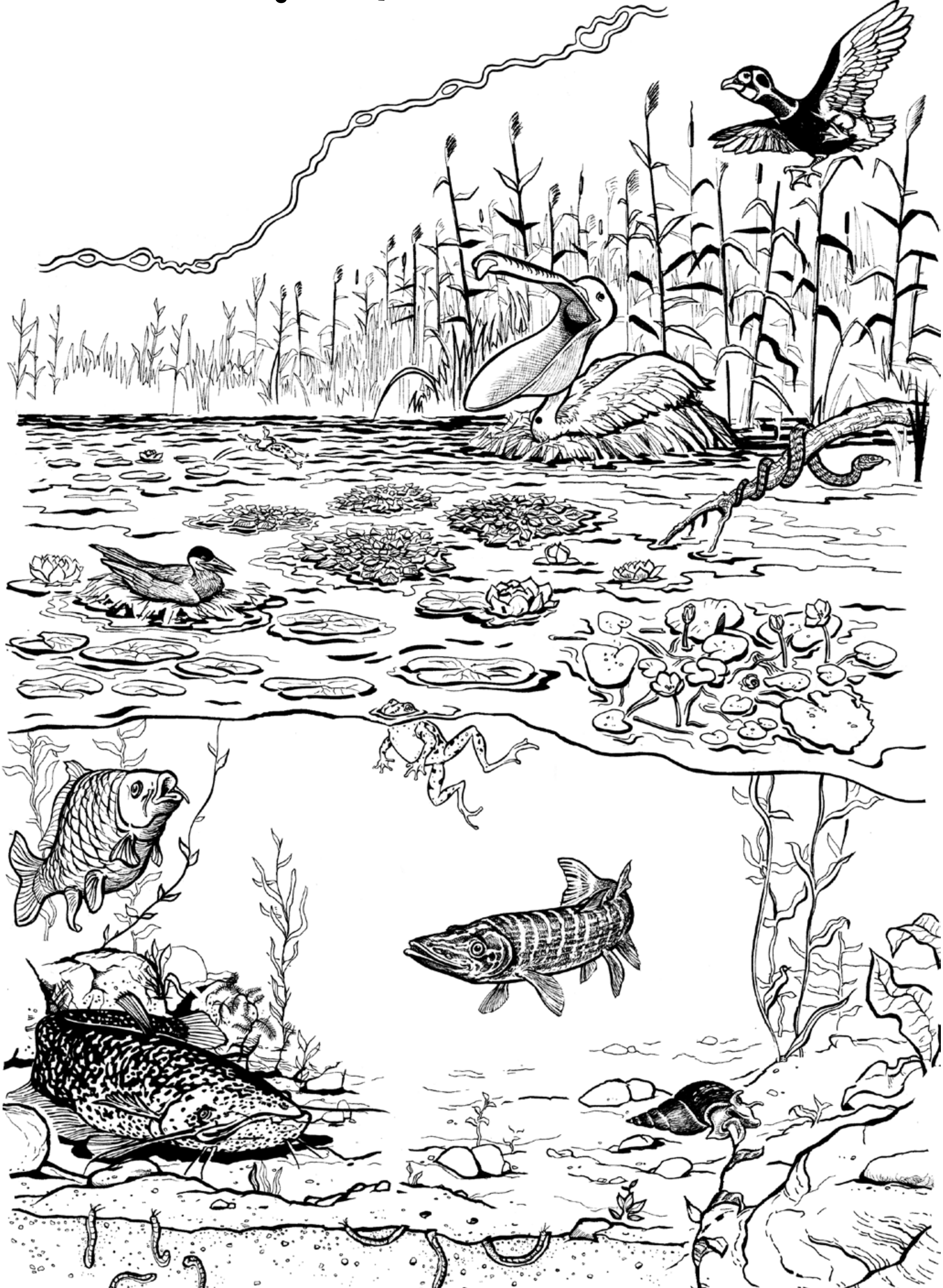


Habitat "Reed stand"

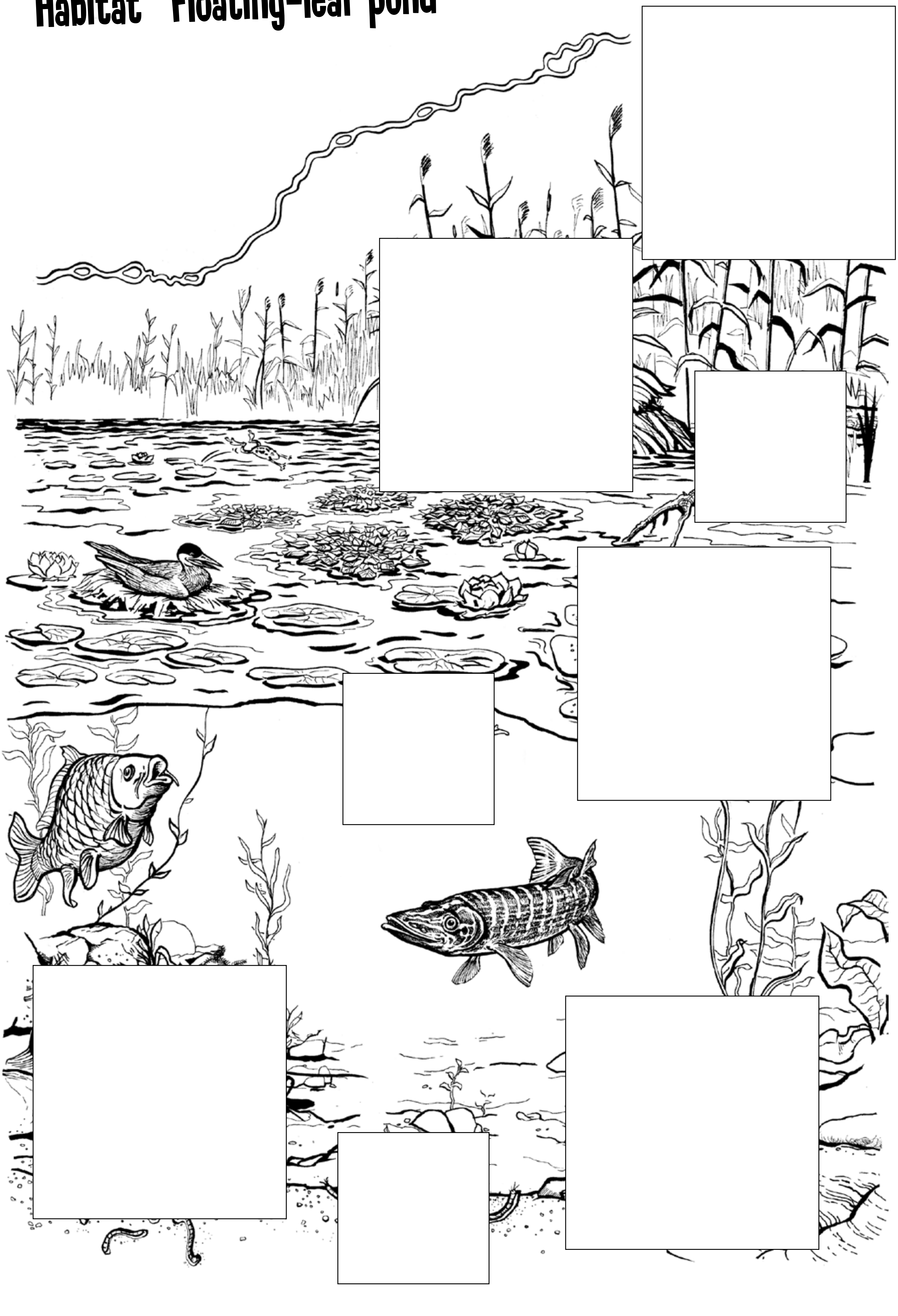
Habitat "Reed stand"



Habitat "Floating-leaf pond"

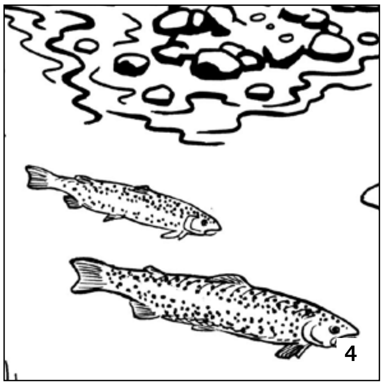


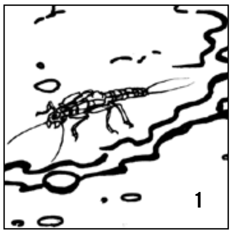
Habitat "Floating-leaf pond"



Habitat "River arm with gravel island", cards

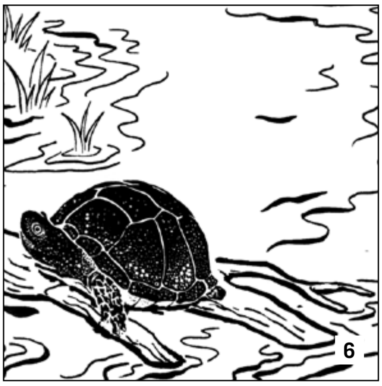
Cut the cards and stick them on the right spot in the habitat picture "River arm with gravel island".

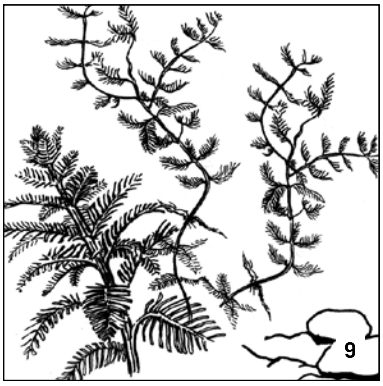


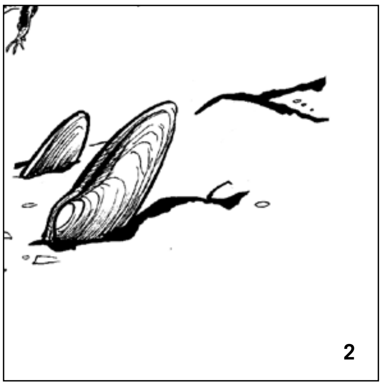


Habitat "Floodplain forest (I)", cards

Cut the cards and stick them on the right spot in the habitat picture "Floodplain forest (I)".







Habitat "Floodplain forest (II)", cards

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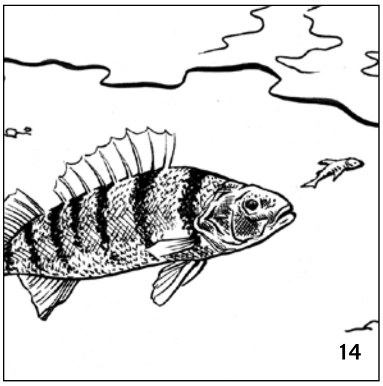

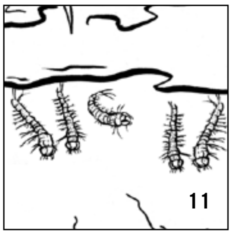

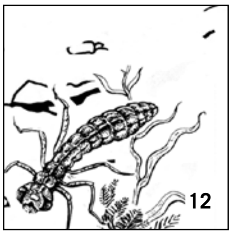

Habitat "Reed stand", cards

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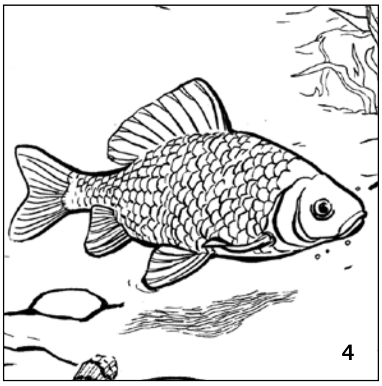
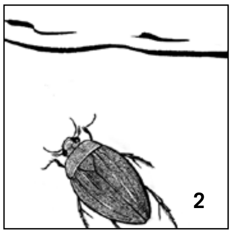
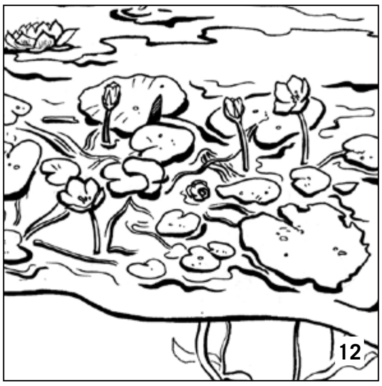
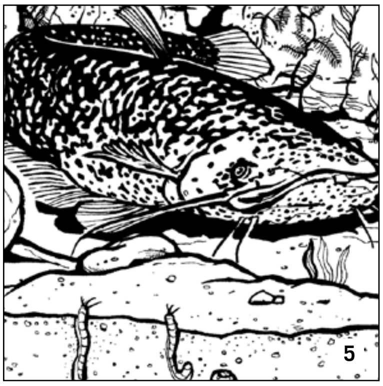


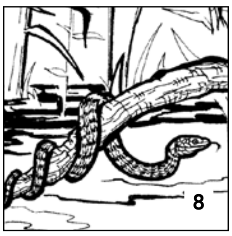


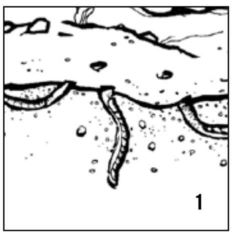
Habitat "Floating-leaf pond", cards

Cut the cards and stick them on the right spot in the habitat picture "Floating-leaf pond".









Characterisation of typical habitats

River arms with gravel islands

In the middle course of rivers there are sections in various side arms whose course constantly changes. As a result, gravel banks often shift and large areas stay continually free of vegetation. There is a big difference between high water and low water. In river arms with gravel islands there are specialised inhabitants among the fauna of the river. These habitats are also an important spawning ground for fish. Some types of sturgeon previously migrated to the lower end of these stretches to spawn, for example at Komarno on the Danube.

Floodplain with oxbow lakes

The floodplain with oxbow lakes is prevalent from the middle courses of all rivers. In valleys, rivers could previously have spread very widely during floods. The floodplain forests therefore covered large areas next to the river. In the lower middle courses they were often penetrated by several arms of the river, which continually carried their banks away. Cut-off side arms and oxbow lakes enrich the spectrum of water habitats.

Well-preserved floodplains were historically often hunting grounds of rich royal families. A modified form of this habitat is for example the flooded pastures and meadows along the Sava (Lonjsko Polje, Croatia).

Floating-leaf ponds

Floating-leaf ponds are the large oxbow lakes and shallow lakes of the Danube delta. They have changing water levels in the area that is influenced by river flooding. They are mostly shallow and in the process of turning into dry land. Many plants prefer waters with summer warmth, the floating-leaf ponds in the lower Danube are therefore particularly densely covered with vegetation. Productive fish waters like floating-leaf ponds attract rich bird life around them.

Reed beds

Reed beds are at an advanced stage of turning into land on the edges of the oxbow lakes and lakes of the Danube delta. Reeds are assertive plants and drive out most other plant species in shallow water. Reed beds are breeding grounds for many species of water bird. They are the habitat for specialised insect fauna and a retreat for less competitive fish species. The floating reed islands of the delta are the result of the reed beds adaptating to changing water levels.

Natural floodplain forest: one of its important functions is flood protection. *photo: Ervin Mezei*

"Habitats of the floodplain"

My animal or plant:

The habitat of my animal or plant:
Describe the habitat, taking the "habitat picture" into account.

If possible, give a brief description of what the animal or plant looks like, or paint it:

Danube tales

The Danube as a route for spreading new flora and fauna – neobiota in the Danube basin

“New species”, called neobiota in the specialist jargon, are not really new. They are only new to us in the Danube basin. Humans began very early on to bring animal and plant species from other continents to the area, for various reasons, such as scientific curiosity or economic interest, and sometimes they came as “unintentional passengers”.

These “new species” change the previously existing ecological balance and can occasionally also push out less assertive species that have previously been living in an area.

These changes do not just affect rivers, but on rivers are particularly good preconditions for new colonisation to take place. Especially in the floodplain forest, disturbances such as regular floods are common occurrences. As a result many areas come into being that are just waiting for new colonisers. They are conquered above all by animal and plant species that have developed good strategies for coping with these unstable circumstances. These communities can be changed much more easily than those that are in a relatively stable ecological balance, such as woodland ecosystems.

In addition, river courses are ideal migratory routes for new species: seeds and parts of plants are washed onwards by water; animals can actively wander up and down stream.

The newly created waterways, which have broken down the natural boundaries of the Danube, are of decisive importance for mixing aquatic habitats inland. In the past two centuries many canals have been built in Europe, linking the different river systems with each other. Many aquatic animal species find their way into these newly available waterways, sometimes actively migrating, sometimes carried by ships and boats. Most recently, when the Main–Danube canal was opened, in 1992, it connected the Rhine and Danube, and thereby the North Sea and the Black Sea, which led to the exchange of species between these two river systems.

For examples of new animal and plant species, see at “Additional information for teachers”.