PROJECT BOOKLET

PLASTIC PIRATES

An Initiative of the Federal Ministry of Education and Research

Science Year 2016★17

SEAS AND OCEANS

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THE PROJECT BOOKLET PLASTIC PIRATES – THE SEA STARTS HERE!

This **project booklet** aims to give youngsters aged between 10 and 16 hands-on experience of the issues related to seas and oceans, particularly the problem of plastic waste in seas and flowing waterways. From 1 May to 30 June 2017, all Plastic Pirates are invited to explore seas and oceans, as well as rivers and streams, and their importance for humans as part of the project.

The key questions for the Plastic Pirates are as follows: **How bad is plastic waste pollution in flowing waterways and seas in Germany? What kinds of plastic are particularly common in the environment and what impact does this have on our seas and oceans?**

This project booklet helps youngsters find their feet during the excursion and serves as a scientific guide to data collection.

The tone of the booklet is aimed at the youngsters themselves. It has been designed in such a way that they can complete the various steps of the project independently. Help them in your role as an educator.

The project booklet is suitable for use in a group of between 6 and 30 youngsters, whether a school class, a work group or a club. Including preparation and follow-up work, the project takes about three days, or six to eight teaching hours, to complete – plus approx. two hours for sampling. As different amounts of time can be allocated to the individual stages, the project booklet is also well suited to integration within a project week.

BACKGROUND INFO: THE SCIENCE YEAR

The German Federal Ministry of Education and Research (BMBF) has been organising Science Years in conjunction with Wissenschaft im Dialog (WiD) since 2000. Each Science Year focuses on a socially relevant and forward-looking issue from the field of science and research. The Science Year 2016*17 – Seas and Oceans is supported by the German Marine Research Consortium (KDM) as a specialist partner.

Seas and oceans account for about 70 per cent of the earth's surface. They are climate regulators, a source of food and a place of business – and they are also home to scores of plants and animals. Researchers have been exploring the oceans for many years, but they remain mysterious, with large sections still uncharted. The Science Year 2016*17 is all about discovering seas and oceans, protecting them and promoting their sustainable use.

One aim of the current Science Year is to raise awareness of the complex issues of marine protection and sustainability amongst children and young people in particular and to show that personal initiatives – such as those within the 'Plastic Pirates' project – can make a big difference.

You can find more information about the Science Year 2016*17 at:
www.scienceyear.de

An Initiative of the Federal Ministry of Education and Research

Science Year 2016*17
SEAS AND OCEANS

WHAT TEACHERS AND GROUP LEADERS NEED TO KNOW

A torn plastic bag on the riverbank or a yogurt pot floating in the water are symptoms of serious interference with the highly complex system of seas and oceans. The 'Plastic Pirates' project focuses on this plastic waste problem and our future handling of it, but aims to familiarise the young people with the general topic of oceans and water cycles in the process. They will learn what it means to work scientifically – and try their hand at it.

Citizen science projects give people interested in science an opportunity to play a hands-on role in the research process. The 'Plastic Pirates' youth science project is one such example, contributing to research into the spread of both macroplastic and microplastic in and around German rivers.

This booklet provides a step-by-step guide to conducting the project (including preparation and follow-up work). The research data collected by many groups throughout Germany will, during the course of the project, be used to create a scientifically sound, digital map of Germany online. In a second stage, this data will be evaluated by Kieler Forschungswerkstatt in conjunction with Professor Thiel (Universidad Católica del Norte in Coquimbo, Chile).

The learning materials and worksheets for the 'Plastic Pirates' youth project

Alongside this project booklet, teachers and group leaders at clubs/associations can also access supporting learning materials and worksheets on the topic of seas and oceans. These materials are suitable for educational work in both curricular and extra-curricular settings. They contain exercises for the youngsters, are structured in a modular way and can be ordered free of charge at **www.plasticpirates.scienceyear.de**

THE SEA STARTS HERE FOR YOUNG PEOPLE

This booklet puts you in control. You decide which river you want to search for plastic waste. You take the samples. You measure, weigh and collect the data – and enter it on our map of Germany at **www.plasticpirates.scienceyear.de** by 15 July 2017. In other words, you don't just 'play' at being scientists – you are scientists.

This booklet will tell you exactly how it works and what you need to know. It will guide you through the project over the next few pages. Each step is an important building block for scientific study and ensures that your data is reliable and usable when you have finished.

You will use a range of methods to gain an insight into the waste in and around the river and to record your findings. The booklet contains specific instructions for each method. Split into groups – with each group concentrating on one aspect of the issue of waste.

THE BEAUTY OF THE OCEANS

Seawater makes up two thirds of the earth's surface, which is why earth is a blue planet when seen from space. The seas and oceans are the largest connected habitat on our planet. They are important and precious – and more than half of the world's population live in coastal areas.

People who do not live on the coast are also connected to the sea via rivers. The oceans are a source of pleasure whenever we go swimming and surfing, relax on the beach or enjoy a seaside holiday. We use them as a shipping route and search for new natural resources.

At the same time, the seas and oceans are also under threat, for example due to pollution caused by plastic waste. The 2016*17 Science Year – Seas and Oceans aims to get you excited by the habitat of the world's seas. By taking part in the 'Plastic Pirates – the sea starts here!' project, you can help protect the world's seas and the creatures that live there. With the studies that you will carry out on German rivers, you will help scientists to find out where the plastic waste comes from that enters the seas and oceans via rivers. All rivers eventually flow into the sea.

On the following pages, you will find out about certain special habitats found in seas and oceans, as well as the creatures that usually live in them.

The deep sea

Even today, the deep sea largely remains a mystery.

Scientists know more about the surface of the moon than they do about large sections of the underwater regions of the world. That's because planets and moons can be charted using telescopes and satellites. Back down on earth, however, the sea itself blocks our view of the seabed. In order to penetrate the depths of the ocean and transmit data and photos from the seabed, it is necessary to send various measuring instruments and robots on complex missions. Sometimes, scientists discover new species in the deep sea or are able to photograph creatures that no one has ever seen before.

Large swathes of the seabed are made up of wide plains covered in sediment. Only very few creatures live here, as they are reliant on food that trickles down from above. When a whale dies and its corpse sinks to the bottom of the sea, it provides an abundance of food for all kinds of deep-sea dwellers.

The polar regions

The Arctic and Antarctic are amongst the coldest, windiest, darkest and stormiest regions on the planet.

The Arctic is an enormous area that makes up about five per cent of the earth and four per cent of the world's seas and oceans. It is made up of a large ocean that is partially covered in ice in winter and summer and surrounded by continents.

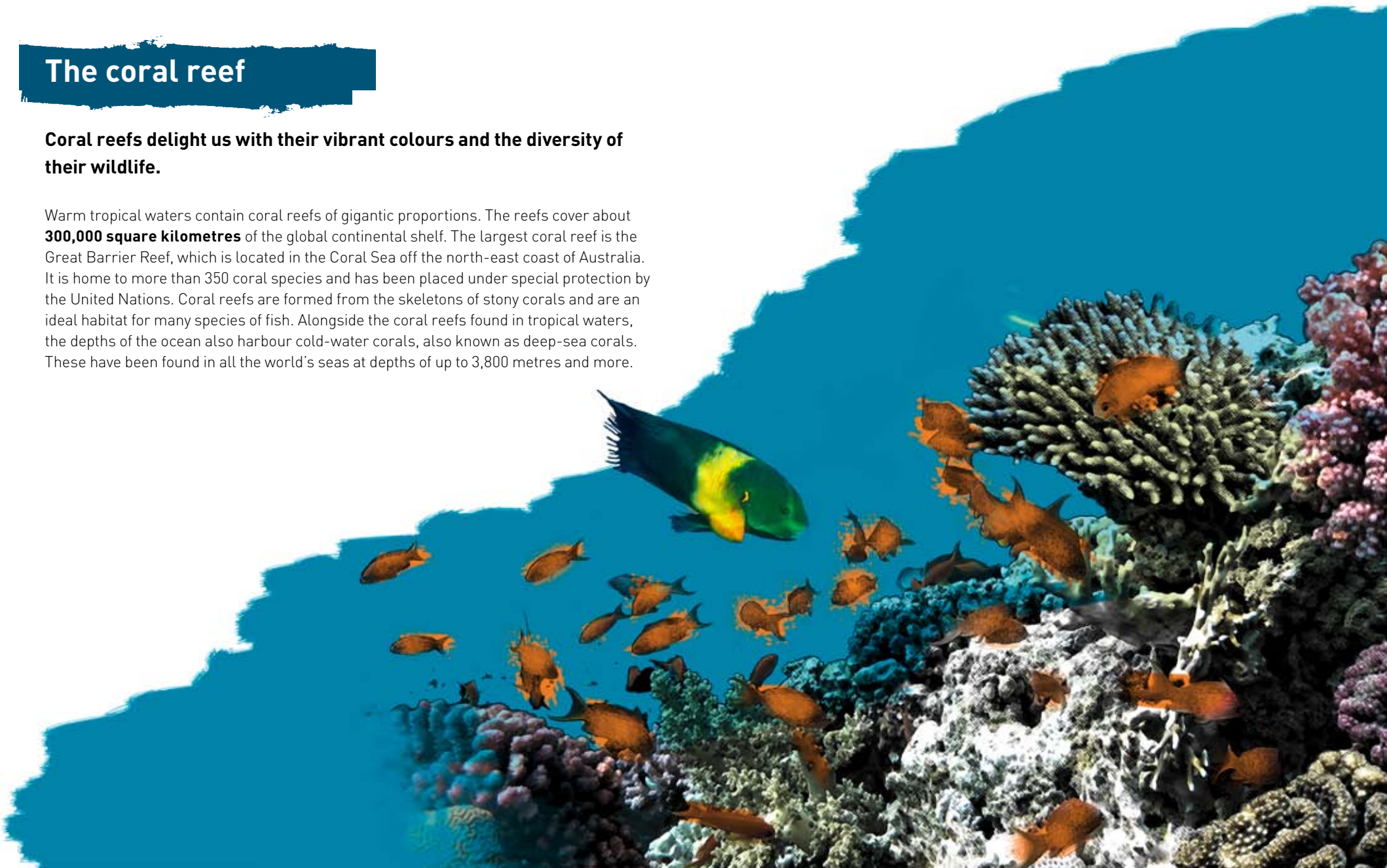
The Antarctic, on the other hand, is a giant land mass, Antarctica, 98 percent of which is covered by a layer of ice that is more than four kilometres thick in places. The lowest temperature ever recorded was -89.2 degrees Celsius and was measured at the Vostok Station in the Antarctic. This place at the pole where the lowest temperature was recorded is also known as 'the world's pole of cold'.

During the short polar summer, the sun doesn't set and its strong rays, combined with the large quantities of nutrients found in the cold waters, give rise to huge plankton blooms (i.e. massive numbers of vegetable and animal plankton). As a result, many species migrate to the polar regions to reproduce or feed, such as the large fin and humpback whales. The Antarctic, which is twice as large as the US in winter due to the formation of sea ice, is also home to a small light shrimp known as krill. It is found in large swarms and is regarded as one of the most specially adapted animals on earth. Krill are eaten by penguins, seals and whales.

The coral reef

Coral reefs delight us with their vibrant colours and the diversity of their wildlife.

Warm tropical waters contain coral reefs of gigantic proportions. The reefs cover about **300,000 square kilometres** of the global continental shelf. The largest coral reef is the Great Barrier Reef, which is located in the Coral Sea off the north-east coast of Australia. It is home to more than 350 coral species and has been placed under special protection by the United Nations. Coral reefs are formed from the skeletons of stony corals and are an ideal habitat for many species of fish. Alongside the coral reefs found in tropical waters, the depths of the ocean also harbour cold-water corals, also known as deep-sea corals. These have been found in all the world's seas at depths of up to 3,800 metres and more.



GERMANY'S RIVERS –

WHERE THE SEA STARTS

There are more than 1,000 flowing waterways in Germany – from small brooks to large rivers. The longest river in Germany is the Rhine. It is the country's most important shipping route. With a length of 865 kilometres, it flows through three federal states.

Rivers offer habitat and food to a wide variety of flora and fauna. Beavers build their lodges on the river-bank. Birds such as kingfishers hunt, whereas fish such as salmon navigate the rivers in search of suitable spawning grounds.

Some species that were once a common sight on German rivers are now rare. For example, there are only about 4,500–7,000 breeding pairs of kingfishers in Germany. Human activity, such as the straightening of river channels, has led to a decline in many species. But we are now witnessing a turnaround. Thanks to comprehensive environmental protection measures, the populations of rare species are stabilising. The beaver is returning to more and more areas, whilst trout, salmon and sensitive grayling are also repopulating their native habitats.

Rivers are suffering from pollution caused by debris and inadequately treated waste water. Research has already shown that large quantities of waste are carried via rivers into seas and oceans, where they pose a danger to marine wildlife. There are still many questions about where exactly the majority of waste enters the rivers, who is responsible and what impact it has on the river ecosystem. Over the next few weeks, we want you – the Plastic Pirates – to research precisely these questions.

Your local river

Now it's over to you. Over the next few hours and days, your local river will become an object of investigation. But before you start doing field work and taking samples from your river, take a look at the river network as a whole.

Exercises

1. Draw the course of your local river onto the map of Germany.
2. Take a photo of one section of the river and stick it in the box (a drawing is also allowed).
3. Research your river and enter the answers to the following questions on the map:
   - Where is the river's source?
   - Where is its mouth?
   - What larger river or what sea does it flow into?
   - Which big cities does it pass on its way to the mouth?
4. Rate the condition of your river. Is it heavily used or more natural? Has there been any river restoration work (i.e. work done to restore the river to its natural state)?
5. Do you see your river as clean or dirty?

Insert your photo or drawing here!

RIVER POLLUTION

A BIG PROBLEM FOR RIVERS AND OCEANS TOO

Sadly, we humans don't always look after our rivers and seas properly and thus cause different types of pollution:

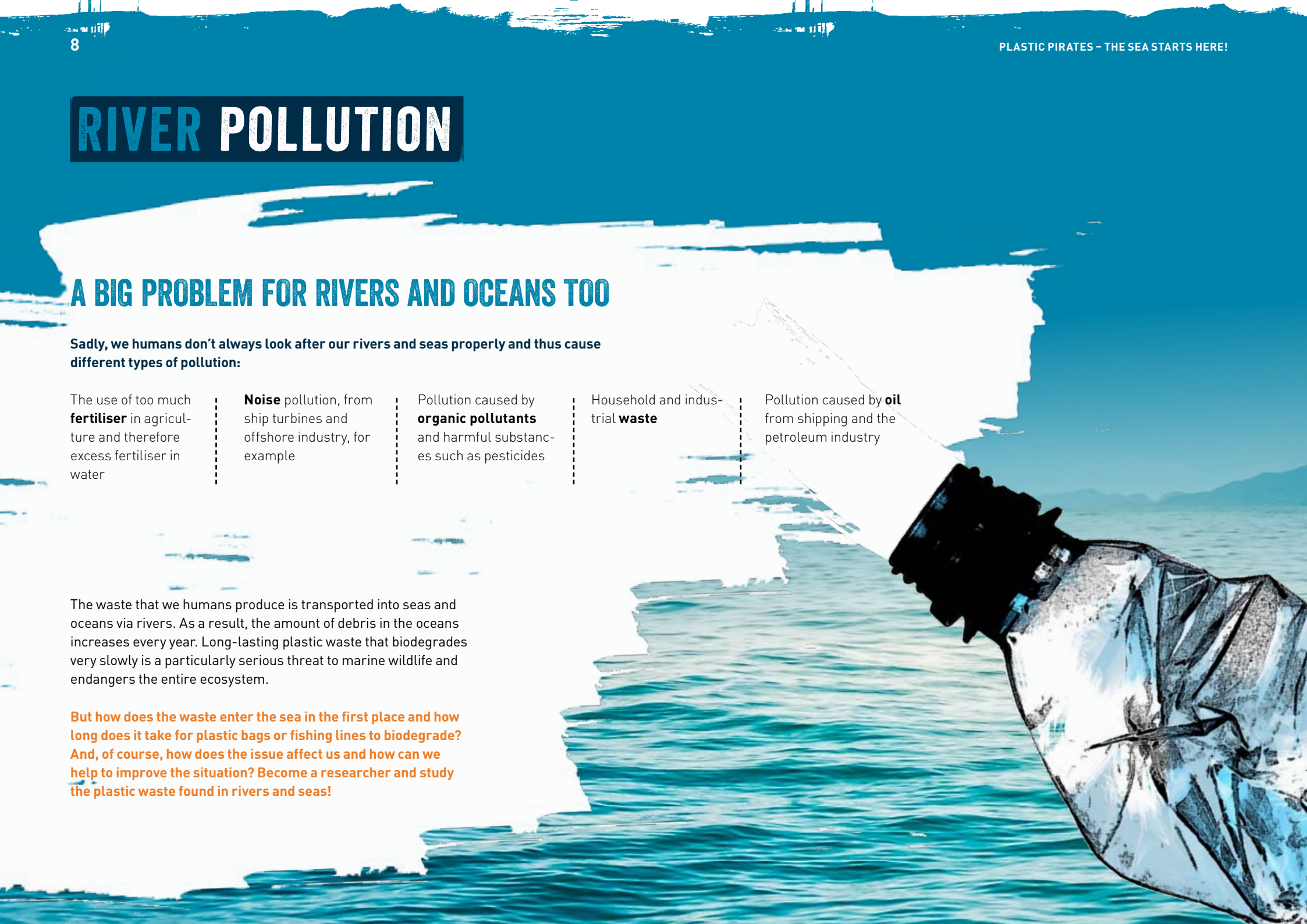
The use of too much **fertiliser** in agriculture and therefore excess fertiliser in water

Noise pollution, from ship turbines and offshore industry, for example

Pollution caused by **organic pollutants** and harmful substances such as pesticides

Household and industrial **waste**

Pollution caused by **oil** from shipping and the petroleum industry



The waste that we humans produce is transported into seas and oceans via rivers. As a result, the amount of debris in the oceans increases every year. Long-lasting plastic waste that biodegrades very slowly is a particularly serious threat to marine wildlife and endangers the entire ecosystem.

But how does the waste enter the sea in the first place and how long does it take for plastic bags or fishing lines to biodegrade? And, of course, how does the issue affect us and how can we help to improve the situation? Become a researcher and study the plastic waste found in rivers and seas!

Microplastics

Microplastics are plastic particles smaller than 5 millimetres. They are formed, for example, when larger plastic particles in the ocean are broken down into ever smaller parts by the sun's rays, the salt content in the water and the movement of waves.

They are also produced industrially and are used, for instance, in cosmetic items such as exfoliation products.

Although they are much smaller than microplastic particles, they also pose a significant risk to marine wildlife. Due to chemical properties, harmful organic substances attach themselves to these tiny particles.

If they are then mistaken for prey and eaten by plankton-eaters or other animals, they enter the food chain.

Macroplastics

Macroplastic refers to all pieces of plastic that are larger than 5 millimetres. These include fishing nets, water bottle lids, cigarette lighters and flip-flops.

Floating macroplastic is dangerous for marine wildlife, as it can be easily mistaken for food and swallowed.

As it cannot be digested, the animals starve to death as their stomachs are full of plastic. Turtles, seals and other animals become entangled in torn-off nets, known as 'ghost nets', get injured and are no longer able to swim. They eventually perish in the nylon fishing nets.

WORKING LIKE SCIENTISTS

When you think of scientists, you might have an image in your mind of old men in white coats with crazy hair. The reality is very different.

Researchers do not spend all day in the lab, performing experiments and gathering data. They also attend specialist conferences, supervise students, produce charts and communicate with colleagues. It's a highly exciting and diverse profession. See for yourself ...

Now that you have learnt so much about our oceans and rivers and have gained important knowledge about the problem of waste, it's time to research the issue more closely. It's time for a scientific study.

You should be clear about three things:

- This is a scientific study in which you are gathering important research data on waste. This data will be published afterwards.
- The study will be carried out by many young people all over Germany, so it is important that everyone sticks to exactly the same method.
- And thirdly: you are the researchers.

In the next few hours, you should therefore work through the 5 STEPS of any scientific experiment:

STEP 1: Formulate a research question!
STEP 2: Make hypotheses (before starting their experiments, scientists make predictions about what they expect the results to be. These are then checked).
STEP 3: Plan the research method.
STEP 4: Carry out the experiment, gather data.
STEP 5: Evaluate and compare your results.

On the hunt for waste

It is now time to plan the sampling procedure. We want to gain an insight into the rubbish by and in the river and record it using a variety of methods. Split into groups – with each group concentrating on one aspect of the issue of waste.

Look at the illustration on the next page and read through the research questions for each group (page 14 onwards). Split into groups, with each group selecting an aspect of the study that they will examine in more detail.

River sampling – let's go!

Samples are taken from German rivers using a particular scientific method.

As it is not possible to take samples of all rivers from source to mouth, we will use random sampling. This will give us a considerable body of data about the prevalence of plastic by and in German rivers.

The same method will be used at all sampling sites, enabling us to compare the data at a later stage. This is only possible, of course, if everyone sticks to the predefined method.

GROUP 1

River description and river speed (page 14)

GROUP 2

Rubbish on the riverbank (page 16)

GROUP 3

Rubbish patches (page 18)

GROUP 4

Floating waste (page 20)

GROUP 5

Team of reporters (page 24)

EXTRA GROUP

Microplastic on the riverbank (page 26)

Read through the research questions for your group and write them down in the space below.

Group number:

Research questions:

1.

2.

3.

PREPARING TO TAKE SAMPLES

To enable you to compare your results online with other groups at a later stage, it is important that all groups across the country apply the same method.

Now read your sampling method carefully on the worksheet and fill in the boxes. Start assigning the first tasks to members of your group.

MY GROUP

I would like to do the following job:

Name	Job

Write down the most important aspects of your method in bullet point form:

The sample site

Look for a suitable spot at which to take your samples. When you have decided, think about the following questions:

- How long and wide is the river? Does its appearance change over its course?
- What does the riverbank look like? Think about soil composition, elevations and hollows, and any vegetation. Does the riverbank look the same everywhere or are there big differences?
- How is the area close to the riverbank used by humans? How is the river used?

You will soon realise that every river and every riverbank are different. First of all, you will need to find a suitable spot by your chosen river where you can research different types of waste. Please remember that safety always comes first when doing field work.

Materials list

NOTES

Use Google Earth for remote exploration of your river and find a suitable site as a team. Think about the particular requirements of your group (e.g. access to the river, vantage point, plenty of space, particular ground, etc.)

Requirements for our group's sampling site:

NOTES

Find out the coordinates of your chosen site in DD (decimal degrees) and enter them here:

Latitude .

Longitude .

E.g. Berlin/Spree 52.522864 and 13.374634

Take a screenshot of your sampling site using Google Earth, print it out and stick it in this box. Describe your sampling site (meadows, fields, streets, urban area, etc.)

The pilot phase

A scientific study also includes a pilot phase. This is a trial run of the sampling procedure that helps you prepare for any problems that may occur during the actual sampling. Don't forget that your data forms part of a real scientific study!

Search for your material together and run through your sampling procedure. To do this, look for a large open space (e.g. school playground, empty car park), draw your section of the river in chalk and see where you could take your samples.

Were there any problems? How did you deal with them? What problems do you expect to encounter when taking samples from the river and how might you solve them?

Problem	Solution

Exploring the riverbank! If possible (and allowed), explore the surroundings of your chosen site before taking samples. Take photos so that you can show them to other groups. Imagine how you will apply your method at the site, taking into account the materials required and the various tasks that need to be completed. Can you identify any further obstacles? Complete the list above.

GROUP 1

River description and river speed

RESEARCH QUESTIONS

1. What do the river and the river bank look like and how are they used? Is there any connection between the form and appearance of the river and the rubbish present?
2. What species of plants and animals live here and how are they threatened by the rubbish present?
3. How quickly does the river flow? What impact might this have on the distribution of the waste in and around the river?

METHOD

1. Make a sketch of your sampling site. Sketch the river channel, as well as paths and bridges. Also sketch any land use (e.g. farmland, beaches, industrial sites, car parks) and indicate the nature of the river bank (e.g. meadow, cliff, sand, mud).
2. Explore the nearby area and describe any noticeable flora and fauna. Can you spot any endangered species? Identify at least three species of plant and three species of animal and note them down on page 28.
3. Now measure the flow speed of the river. To do so, find an accessible section of the river that flows straight for at least 20 metres. Be careful – the ground may well be slippery!

3.1 Measure 20 metres along the river bank using a tape measure and clearly mark a starting point at 0 metres and a finishing point at 20 metres with a piece of wood or a stone.

3.2 Now place one of the sticks in the water, level with the starting point and as close to the middle of the channel as possible. Start the stopwatch. Stop the stopwatch as soon as the stick passes the finishing point. Note down on the results sheet (on page 28) the time in seconds that it took for the stick to travel this distance.

3.3 Repeat the measurement with the two remaining sticks and complete the table. Calculate the average.

3.4 Use the following formula to calculate the **flow speed** of your river:

AIMS OF THE SAMPLING

- To produce a description and map of the sampling site
- To identify three important/noticeable plant species and three important/noticeable animal species
- To record the flow speed of the river

REQUIRED MATERIAL

- Pencil
- A field guide or a book on native flora and fauna (optional)
- Binoculars (optional)
- Tape measure or a piece of string, 20 metres long
- Stopwatch or mobile phone
- 3 sticks (possibly found at the site itself)

ADD YOUR SKETCH HERE

START

20 M

FINISH

GROUP 2

Rubbish on the riverbank

RESEARCH QUESTIONS

1. How much waste can be found on the riverbank?
2. What material is the waste made of? Does it float or sink?
3. How likely is it that the waste found on the riverbank will enter the river? Whereabouts on the riverbank is the waste found?

METHOD

1. To take your samples, you need a bit of space on the riverbank. Look for an easily accessible spot measuring approx. 50 × 20 metres.
2. Identify three different riverbank zones:

ZONE A: This zone is in regular (daily) contact with the river and roughly 5 metres wide. Here, you can often see the most recent high-water mark.

ZONE B: This zone is in irregular contact with the river and encompasses the next 10 metres of the river bank.

ZONE C: This zone is not in contact with the river and starts about 15 metres from the river.

3. Now mark out your first transect. This is an artificial line that runs from the edge of the river to the top of the riverbank. It is important that you place your transect at random – and not because you see somewhere with a lot or very little waste!
4. Now set up a sampling point in each of the three riverbank zones (A, B, C): At your sampling point, place a stick in the ground and tie a piece of string measuring 1.5 metres in length around the bottom. Run the string along the ground to trace out a circle. Use small stones to mark the circle. Now trace out the second and third circles in zones B and C. The distance between the circles should always be more or less the same. Use the illustration overleaf to help you.
5. Now search for waste in the first circle and collect it on a white cloth next to the circle. Only collect waste – no natural objects such as wood or plant remnants. Only collect waste that is at least as large as a cigarette butt and this is actually located within the circle, even if other waste is very close by!
6. On a sheet of paper, write down the transect number, the sampling point number (e.g. '1A' means transect 1, river edge sampling point) and the name of your school or club/organisation. Place this sheet of paper next to your cloth and take a photo of the sheet of paper and the waste spread out on the cloth. Check whether the photo's good. You can take a few photos if the waste is hard to make out. These photos will help back up your results later on.

AIMS OF THE SAMPLING

- To identify the different riverbank zones (using the method described)
- To set up sampling points where you can look for waste on the riverbank
- To sort the waste by material

REQUIRED MATERIAL

- A straight stick, approx. 1 metre long
- Piece of string, 1.5 metres long
- Pebbles or similar objects to mark out a circle
- Camera or smartphone
- Paper and a thick felt-tip pen
- A white cloth
- 9 bags (for gathering the waste if this is to be counted later at the school/in the group's room)

7. Count out the items of waste and sort them by material. Enter your data in the results table on page 28.

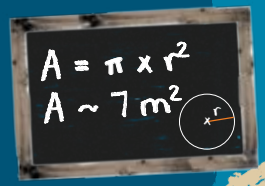
8. Repeat the procedure in the two remaining circles and then mark out a second and third transect. Please ensure that your circles are roughly level with those of the first transect. The distance between the transects should be at least 20 metres.

TIP

If you find a particularly large amount of waste, you can pack it into a bag once you've done step 6 and count it at school or in your group's room. Please ensure that each bag is labelled with the number of the transect and sampling point (e.g. '1A') to avoid mixing up waste from different sampling points.

CALCULATING THE AREA OF THE CIRCLE

In order to work out how much waste there is in 1 m^2 of your riverbank, we first of all need to know the **area of the circle** (A). Use the following formula:



π: Pi = approx. 3.14
r: radius of the circle (= 1.5 m)

EXAMPLE

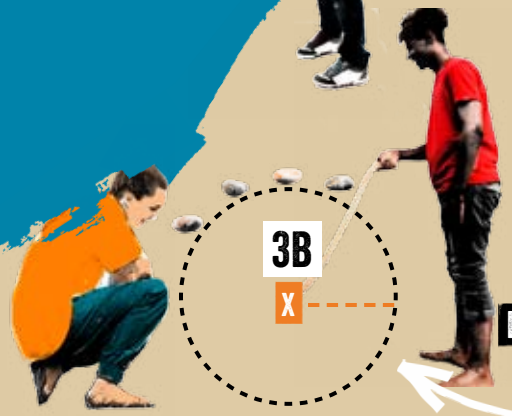
A transect is an artificial line that connects two or more points.

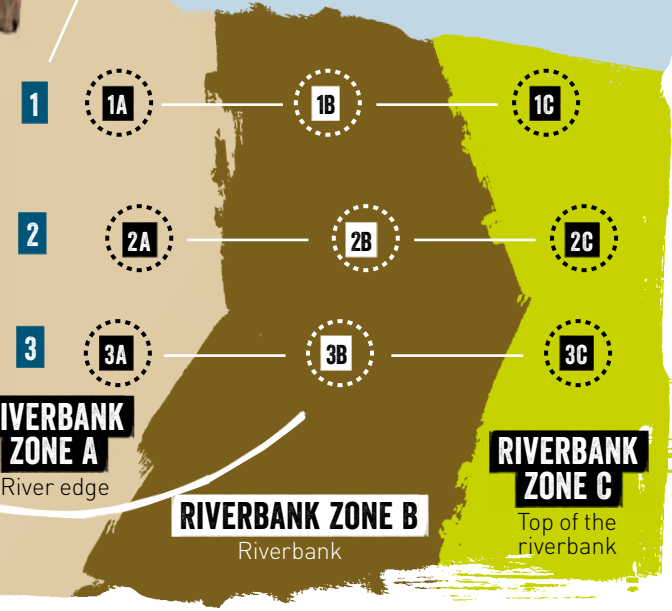
This line is used to set up points for measuring scientific data.

TRANSECTS

RESULTS LOG

Complete the table on page 28!





GROUP 3

Rubbish patches

RESEARCH QUESTIONS

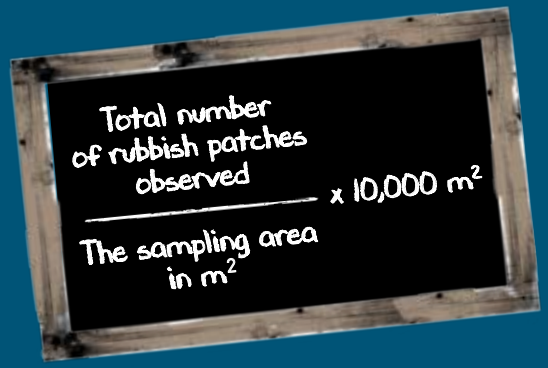
1. Are there rubbish patches on the riverbank? How large are they?
2. What materials are the rubbish patches made of?
3. Are the rubbish patches on the riverbank made up of harmful materials?

METHOD

1. Look for a sampling site: use a large object (stick, rock) to mark a point near the river and record the GPS coordinates (**POINT A**). Write them down in the results table on page 28. Measure out 200 to 300 metres (depending on the site) along the riverbank and note down the length. Mark out **POINT B** with an object and the GPS device. Moving away from the river, measure out a distance of 30 to 50 metres and also note down the width in the results. Set up **POINT C** here and record the GPS coordinates. Mark **POINT D** at the same level as point C to form a rectangle. Once again record the coordinates. Use the illustration overleaf to help you.
2. Walk the area looking for rubbish patches. Make sure that you cover the entire area.
3. As soon as you see several items of waste very close to each other, compare them with the photos on the next page. Decide whether it is a small, medium-sized or large rubbish patch. Agree the definition as a group and record your data in the results table on page 28.
4. Write down on a sheet of paper the number of the rubbish patch (1, 2, 3, etc.), the name of your school/club/organisation and the name of the river. Place this sheet of paper next to the waste and take a photo of the rubbish patch and the sheet of paper.
5. Once you have covered your area, indicate the kinds of dangerous waste that you have found on page 28.

CALCULATING THE NUMBER OF RUBBISH PATCHES IN 10,000 M²

Use the following formula to calculate the number of rubbish patches in an area of 10,000 m².



AIMS OF THE SAMPLING

- To mark out a sampling area and record the GPS coordinates
- To search for rubbish patches and classify them by size and material
- To estimate how many of the rubbish patches contain harmful materials

REQUIRED MATERIAL

- GPS device or GPS-enabled smartphone
- A piece of string at least 10 metres long, ideally longer (to measure the area)
- Tape measure
- Camera or smartphone
- Paper and a thick felt-tip pen

SMALL RUBBISH PATCH

3–10 items

MEDIUM SIZED RUBBISH PATCH

11–25 items

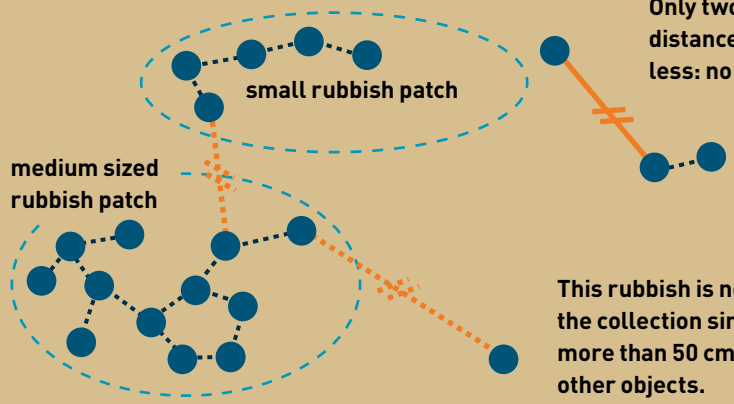
LARGE RUBBISH PATCH

More than 25 items

Example of a correct label:
A note with the name of your school or organisation and the number of the rubbish patch can be seen on the photo.

SAMPLING AREA

Width: 30–50 m



- items of waste
- connect items of waste which are a maximum of 50 cm apart
- are longer than 50 cm

RESULTS LOG

Complete the table on page 28!

GROUP 4

Floating waste

Your group looks at two different types of waste: larger floating items and microplastic.

RESEARCH QUESTIONS

1. How many large items of waste float along the river towards the sea? What is more common – natural floating items such as leaves and twigs or floating items of waste?
2. How large are the floating items of waste and what materials are they made of?
3. How much microplastic is swimming in the river towards the sea?

A NET FOR MICROPLASTIC SAMPLING

If you wish to take part in microplastics sampling, you need a special net. You can borrow this for free using the following contact details. Remember to send your net back to Kieler Forschungswerkstatt once you have taken your samples – also free of charge, of course!

Editorial Office Science Year 2016*17 – Seas and Oceans
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Email: plasticpirates@scienceyear.de
Berlin office hours; 9 a.m. to 1 p.m. and 2 p.m. to 6 p.m., Monday to Friday

METHOD

1. Find a suitable spot for casting your microplastics net. This could be a jetty, a small bridge or an accessible spot on the riverbank.
2. Cast your microplastics net, with the opening facing the opposite direction to the river's current. Stabilise the net so that the river water can flow through the opening. Note down the current time. The microplastics net should be in the river for 60 minutes. You can tie the net to a bridge railing or a bollard and use the time to carry out step 3 (floating items).
3. Start observing floating items. Look for a vantage point that gives you a good view of the entire river. If possible, stay close to your microplastics net so that you can monitor it. If the river is very wide, mark the point up to which you can see the river. To do so, take a photo of an object in the water, such as a buoy or a rock. If you are standing on a bridge, you can also record your GPS coordinates (ask your group leader or teacher to help you). Estimate the width of your river/the section you can see and enter this figure in the results table on page 29.

AIMS OF THE SAMPLING

- To search for microplastic by casting a microplastics net
- To observe floating waste
- To count and classify large floating waste and microplastic

REQUIRED MATERIAL

- Microplastics net (available from the editors)
- String/rope (to cast the net)
- A watch
- Paper for making notes
- Magnifying glass (needed later in the school/group room)
- Tray (needed later in the school/group room)
- Sealable bags (to send off the samples)

4. Keep a lookout for floating waste. As soon as you see an object, try to take a photo of it and make the other members of your group aware of it. Determine its size together and keep a tally chart in the results table. **On a blank sheet of paper, write down which items of waste float past you** (e.g. item 1: see-through plastic, item 2: plastic bottle). Observe the river for 30 minutes.

5. As soon as the period has elapsed, write down the time in the results table. As soon as the microplastics net has been in the water for 60 minutes, bring it in and note down the end time.

6. Seal the net with tape so that it doesn't come open again. Take it to your school or group room to dry.

7. As soon as the net (and its contents) are dry, open it and empty the entire contents onto a tray. Look for microplastic, sort plastic fragments and complete the results table on page 29. Please see page 22 for details of how to recognise microplastic.

8. Pack the entire contents of the net (microplastic and other objects) into a resealable bag and label this bag with the name of your school or organisation. Your teacher/group leader will send this bag to Kieler Forschungswerkstatt along with your microplastics net so that your results can be confirmed.

WIDTH OF THE RIVER

Use Google Earth to check the width of your river in metres from your vantage point and enter the measurement in the results table on page 29.

CALCULATING THE NUMBER OF MICROPLASTIC FRAGMENTS PER 1,000 LITRES OF RIVER WATER

You will need the following data to calculate the number of microplastic fragments per 1 m³ of river water:

- Flow speed in m/s. Ask group 1.
- Area of the net opening. Measure the internal opening of your microplastics net in metres!
  Side a = ... m, side b = ... m.
  Don't forget that not all the net swims in the water. Normally, about 9 to 11 cm of the net is in the water. Therefore, use a value of 0.09 m for b. Calculate the surface area of the opening in square metres = **a × b = ... m².**
- Length of time for which the net was cast, in seconds = ... seconds.

Enter your values in the following formula:

$$\text{Number of microplastic fragments per m}^3 = \frac{\text{Microplastic fragments in the net}}{\text{Flow speed of the river in m/s} \times \text{Area of the net opening in m}^2 \times \text{Length of time (in seconds) for which the net was cast}}$$

WHITE PELLETS

1 cm

MICROPLASTIC IN DIFFERENT COLOURS

SMALL STONES

MICROPLASTIC FRAGMENTS OF DIFFERENT COLOURS

INFO!

IDENTIFYING MICROPLASTIC

It isn't always easy to tell small plastic fragments apart from stones, shards of glass and mussel shells. Take a look at and compare the photos. What are the differences between the four groups? Pay special attention to the differences between white pellets, white fragments and pebbles.


DRY MICROPLASTICS
NET
>
CONTENTS ON
A TRAY
>
SORT AND
NOTE DOWN


RESULTS
LOG
Complete the
table on page 29!
WIDTH
OF THE RIVER
DIRECTION OF FLOW

GROUP 5

Team of reporters

RESEARCH QUESTIONS

1. How successful was sampling?
2. What are the possible sources of waste near the river? Where does the waste come from? Who might be responsible?
3. What possible solutions are there to get the local waste problem under control?

METHOD

1. Search for possible sources of waste in the surrounding area and take photographic evidence. Consider the following sources of waste: overflowing bins by the river, overflowing bins near the river, bulk waste, scrapyards, diverted waste water, gratings.
2. Talk to the other groups and interview them. What methods have they used and what did they aim to research? Were there any major problems? What was their motivation like when taking samples? Complete the results table on page 29.
3. Ask the other groups what waste they have found so far and think about where it might come from. Take photographic evidence.
4. Photograph each group as they take samples. Ensure that all group members can be seen. If possible, take a photo of everyone together (using a self-timer if available) and write the name of your school/organisation and the river on the photo. Anyone interested will be able to see this photo, along with your group name, on the map of Germany at **www.plasticpirates.scienceyear.de**

AIMS OF THE SAMPLING

- To document the sampling with photos or a short video
- To seek out and identify sources of waste
- To gather photographic evidence

REQUIRED MATERIAL

- Camera or smartphone
- A notepad and pen
- Tape measure

ARTICLE ABOUT THE SAMPLING PROCESS

Take a look at your photos and write a short article about your sampling procedure for your school website/the project website. It may include the following:

- the jobs done by each group
- how much waste was found by each group, and what kind
- whether harmful waste was found
- whether any microplastic was found
- the suspected source of the waste
- how you liked the activities
- how river waste can harm plants, animals and humans
- what we can all do to avoid waste in rivers and seas

Publish a few of your photos or a short video.

Who leaves behind what kind of waste? Take a look at the table and think about further evidence that may shed some light on the source of the waste.

Source of waste	Evidence
Residents	Overflowing bins, household waste
Riverside visitors	'Party waste' (barbecue equipment, empty beer bottles)
Fly tippers	Junk
Industry	Microplastic pellets
Shipping	Items that are used on board ships: canisters, waterproof clothing
Waste deposited by the river	Old waste very close to the river
.....	.....
.....	.....

STICK AN EVIDENCE PHOTO HERE AND IDENTIFY THE SUSPECTED SOURCE OF WASTE

EXTRA GROUP

Microplastic on the river bank (optional if there is a sandy beach)
These samples can only be taken if there are sandy sections of the riverbank (river beaches).

RESEARCH QUESTIONS

1. How much microplastic can be found on sandy sections of the riverbank (river beaches)?
2. Compare the microplastic you found on the riverbank with the plastic shown on page 22 and categorise it.
3. Do the microplastic fragments look similar to the food of a species of bird common in the area?

METHOD

1. Identify the high-water mark (the point at which wet and dry sand meet). If you cannot find this line, take samples within the first metre of the riverbank.
2. Lay out a 20-metre-long piece of string along this line and mark out three points – at the start, middle and end of the length of string.
3. Measure out a 50 × 50 cm square at each of these points and mark it out in the sand.
4. Go to the first square. Remove all larger natural objects (e.g. stones, algae, plants, wood). Use a spade to dig about 2 cm into the sand within (!) the square and deposit it on a tray.
5. Filter the sand on the tray with the microplastic sieve. Place everything left behind in the net onto another tray. If the sand is damp, do not filter it on the beach, but pour it into a bag. Label the bag with the number of the sampling point (1, 2 or 3), close it securely and take it with you back to your school/group room. Here, leave your sand to dry in an appropriately labelled tray and filter it as soon as it is dry. Place everything left behind in the net onto another tray.
6. Now study the contents of the tray carefully. Sort microplastic into one corner of the tray, count the plastic fragments and pellets and complete the results table on page 29. Please see page 22 (group 4) for details of how to recognise microplastic.
7. As soon as you have counted all the microplastic fragments and entered them in the table on page 29, label the bag with the name of your school/organisation and the number of the sampling point (1, 2 or 3) and pour the entire contents of the tray (even items that are not plastic) into the bag. Seal the bag.
8. Repeat the procedure with the second and third samples.

AIMS OF THE SAMPLING

- To determine the high-water mark and to trace a transect along the sandy beach
- To separate microplastic and sand by filtering
- To identify and classify microplastic

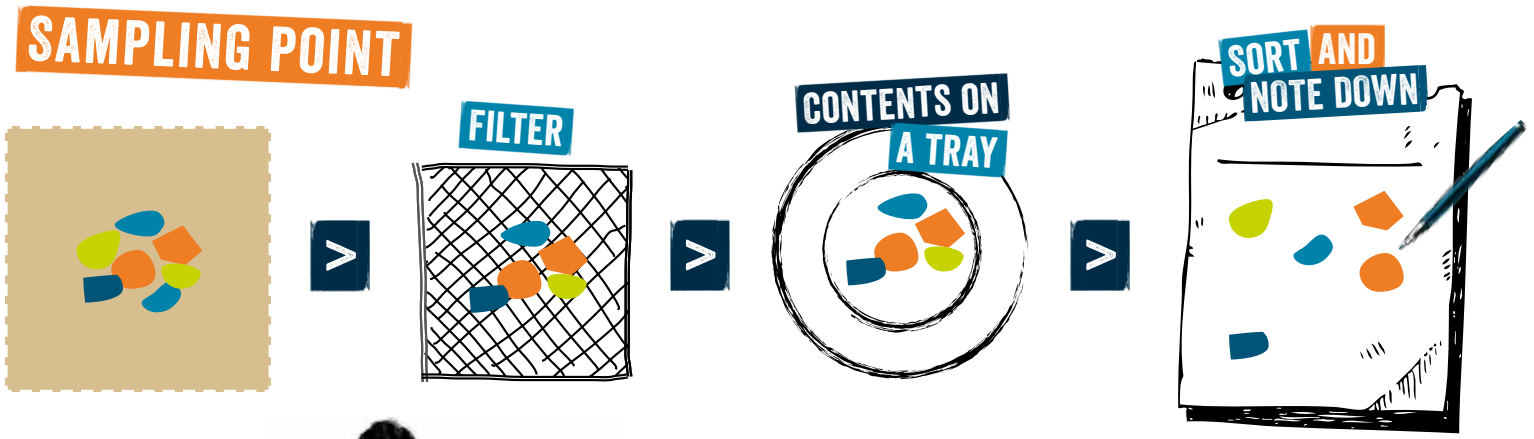
REQUIRED MATERIAL

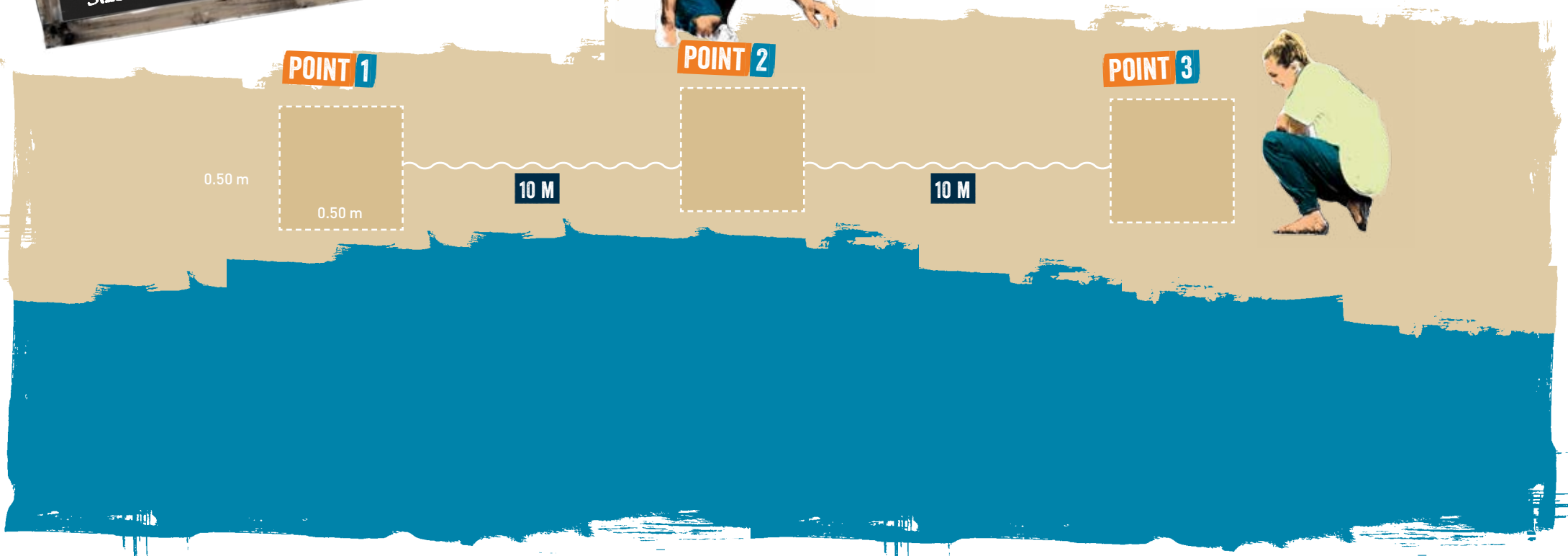
- Microplastic sieve, mesh width: 1 millimetre. You will find assembly instructions here: **www.plasticpirates.scienceyear.de**
- Piece of string, 20 metres long
- Small spade or tub to dig out the sand
- 3 sealable bags to hold the samples

CALCULATING THE SAMPLING AREA

- Work out the size of your sampling squares in square metres: **Side a in metres × side b in metres = … m²**
- Work out the number of microplastic fragments per square metre at each sampling point: Number of microplastic fragments per square metre found at each sampling point/area.
- Calculate the mean average of the three sampling points in order to find out how many microplastic fragments are found in each square metre of beach.

It is important that the microplastic sieve has a mesh width of 1 mm so that the microplastic fragments remain in the sieve.





RESULTS
HOW POLLUTED IS OUR RIVER?

Once you have entered your results, ask the other groups to complete the tables. You will then have an insight into your river and the types of waste present.

GROUP 1 River description and river speed

Flow speed

Run	Time in seconds
1st stick	
2nd stick	
3rd stick	
Average	

m/s

km/h

3 noticeable animal species

1 .....

2 .....

3 .....

3 noticeable plant species

1 _____

2 _____

3 _____

GROUP 2

Rubbish on the riverbank

Most common material

	Transect 1			Transect 2			Transect 3			
	Sampling point A	Sampling point B	Sampling point C	Sampling point A	Sampling point B	Sampling point C	Sampling point A	Sampling point B	Sampling point C	Total
Paper										
Cigarette butts										
Plastic										
Metal										
Glass										
Food leftovers										
Other waste										
Total										
Per 1 m²										

Waste per 1 m² in each riverside zone:

River edge (average of A+A+A)

Riverbank (average of B+B+B)

Top of the riverbank (average of C+C+C)

GROUP 3 Rubbish patches

	Small	Medium	Large	Total
number of rubbish patches				
Pro 10.000 m²				

Sampling area

Width	Length	Area in m²

Point	Coordinates
A	North
	East
B	North
	East
C	North
	East
D	North
	East

What kind of harmful waste have you seen?

- ☐ Shards of glass
- ☐ Sharp metal objects
- ☐ Rotting food leftovers
- ☐ Used personal hygiene items
- ☐ Chemicals (batteries, paint ...)

GROUP 4 Floating waste

Microplastics

Start time : End time : Time in minutes

	Pellets	Fragments	Total
Number of fragments caught			
Number per 1,000 litres of water			

Floating items

Start time : End time : Time in minutes

	Floating waste	Natural floating items
Small (size of an apple)		
Medium (size of a football)		
Large (size of a bucket)		
Total		

River width in m:

EXTRA GROUP

Microplastic on riverbank

Microplastic fragments	Sampling point 1	2	3	Total
Pellets				
Fragments				
Total				
Per 1 m²				

GROUP 5 Team of reporters

Sources of waste	Yes	More so	Possibly	Less so	No	Evidence
Residents						
Riverside visitors						
Fly tippers						
Industry						
Shipping						
Deposited by the river						

Problems during sampling	No problems	Hardly any problems	Some problems	Lots of problems	Sampling halted
Group 1					
Group 2					
Group 3					
Group 4					
Extra group					

The biggest problems

UPLOAD YOUR DATA

Once you have evaluated your findings as a team, you should now upload the key data, as well as your photos, to **www.plasticpirates.scienceyear.de**. Think about a name for your group, which you will use when uploading your results so that other project groups can compare their findings with yours.

Go to the website and fill in the fields shown. Ideally, you will nominate one person to enter all the data. Kieler Forschungswerkstatt also needs your original results to scientifically evaluate and interpret your data. Please therefore also upload a scan or photo of the completed results pages (28 and 29). Please submit your data until 15 July 2017.

If you have more than 20 photos and additional material (e. g. photos taken by Group 5, of the river and its surroundings etc.), we would be glad if you send them to **plastikpiraten@forschungs- werkstatt.de**!

Your data is online – what happens now?

Your work is now done and you will be automatically entered into the prize draw. It's now time for others to get to work. It all lies in the hands of Kieler Forschungswerkstatt, who – together with Professor Thiel (Universidad Católica del Norte in Coquimbo in Chile) – will scientifically evaluate the data submitted by all project groups. As this is such a large-scale study, it will take a bit of time to make everything absolutely watertight in line with the highest scientific standards. We will, of course, keep you posted.

But one thing is certain:
Your data will form part of an important study that is already eagerly anticipated in the scientific community and that will probably make a splash far beyond it.

Plastikpiraten – Das Meer beginnt hier!: Wissenschaftsjahr

https://www.wissenschaftsjahr.de/jugendaktion

Reader

NAME OF YOUR GROUP

SAMPLING DATE

. . (DD.MM.YYYY)

NAME OF THE RIVER

COORDINATES OF YOUR SELECTED SITE (page 13)

Latitude .

Longitude .

YOUR GROUP PHOTO

GROUP 1

- Flow speed of your river: metres per second

GROUP 2

- Rubbish on the riverbank: Items of rubbish per 1 m²
- Most commonly found material:
  - ☐ Paper
  - ☐ Cigarette butts
  - ☐ Plastic
  - ☐ Metal
  - ☐ Glass
  - ☐ Food leftovers
  - ☐ Other waste

GROUP 3

- Rubbish patches per 10,000 m²
- Harmful material:
  - ☐ Shards of glass
  - ☐ Sharp metal objects
  - ☐ Rotting food leftovers
  - ☐ Used personal hygiene items
  - ☐ Chemicals

GROUP 4

- Floating waste: items of waste were observed
- Microplastic: microplastic fragments per 1,000 litres of river water

EXTRA GROUP

- microplastic fragments per 1 m² of river beach

IMAGES OF FINDINGS AND ORIGINAL DATA

- Photos of waste collected at the sampling points (Group 2)
- Photos of the rubbish patches (Group 3)
- Photos of floating waste (if available, Group 4)
- A photo/scan of page 28 and page 29 with all data collected

A maximum of 20 photos can be uploaded using the online form.
If you have more than 20 photos or additional material, please send this to plastikpiraten@forschungs-werkstatt.de

Filling in the form may take up to 20 minutes.

COMPARING RIVER WASTE IN GERMANY

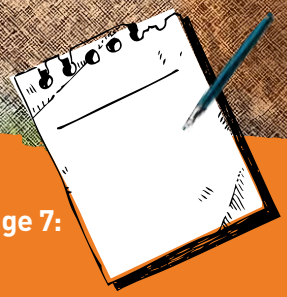
Go to **www.plasticpirates.scienceyear.de** and compare your data with that of other project groups all over Germany. Complete the table and answer the following questions.

COMPARING RESULTS:

	Our results	German average
Flow speed of the river in metres per second		
Items of rubbish per 1 m² of riverbank		
Material found most often		
Rubbish patches per 10,000 m² of riverbank		
Total number of items of floating waste in 30 minutes		
microplastic fragments per 1,000 litres of river water		
Microplastic fragments per 1 m² of river beach		

Find answers to the following questions:

- Did other project groups find more or less waste than you?
- Is there anywhere in Germany where a lot of waste of a particular type was found?
- What might the reasons be?
- What materials is river waste in Germany made from?
- Are your samples different in any way?
- Where do you think the waste in the various regions of Germany comes from?
- Which rivers carry the most waste into the sea and why (e.g. size and length of the river, total amount/volume of water, proximity to cities and industrial sites)?



Mark the following on the map of Germany on page 7:

- The sampling sites with the largest prevalence of each kind of waste
- Your river and your sampling site
- A particularly fast-flowing and a particularly slow-flowing river

Compare these flow speeds with your river and discuss what impact they might have on riverbank waste.
Write down a few ideas in note form.

EVALUATION AND FOLLOW-UP WORK

Group number

Once you have your results, it's time to answer your group's research questions.

Answer to research question 1:

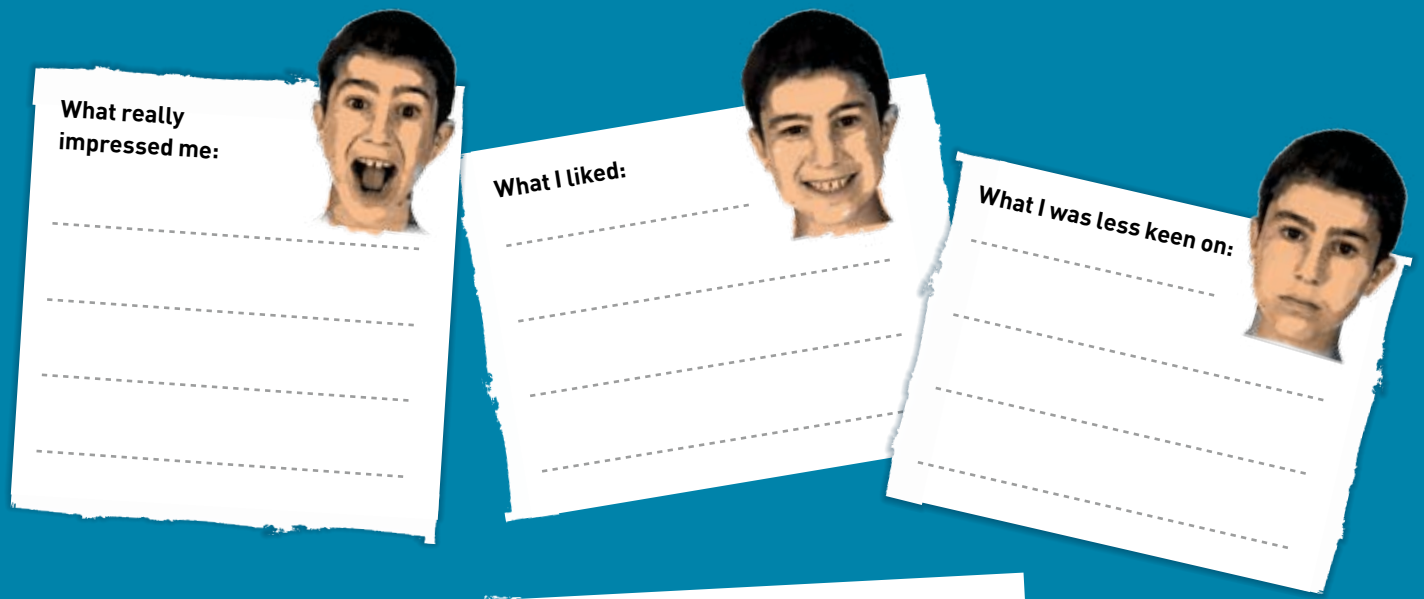
Answer to research question 2:

Answer to research question 3:

HAVE ANY NEW QUESTIONS CROPPED UP?

WHAT WERE YOUR EXPERIENCES OF THE SCIENTIFIC STUDY?

How was sampling?
Fill in the boxes.



RATING

What is your view of waste pollution on your river? Give a rating from A to F, with A being the best rating and F being the worst.

A ☐ B ☐ C ☐ D ☐ E ☐ F ☐

No pollution → Severe pollution

WHAT MAKES ME THINK – AND INSPIRES ME TO ACT.

QUESTIONS THAT TAKE YOU FURTHER.

What do you regard as the greatest challenge?

Who would you like to tell about the project, and why?

How has the project changed your view of the issue of plastic waste?

What have you learnt about yourself throughout the project?

What did you find particularly surprising during the programme?

How has your understanding of the term ‘science’ changed over the course of the project?

Partners

The youth programme 'Plastic Pirates – the sea starts here!' is part of the Science Year 2016*17 – seas and oceans of the German Federal Ministry of Education and Research (BMBF) and is carried out in cooperation with ozean:labor at Kieler Forschungswerkstatt and the marine biology work group of Universität Católica del Norte in Coquimbo, Chile. The Plastic Pirates are based on the joint international project 'Dem Plastikmüll auf der Spur/Cientificos de la Basura' ('On the hunt for plastic waste'). The project is carried out and supported by the German Federal Ministry of Education and Research, the cluster of excellence 'The Future Ocean', the Lighthouse Foundation, the Leibniz Institute for Science and Mathematics Education (IPN) and the Ministry of School and Professional Education of the state of Schleswig-Holstein. On the Chilean side, the project is supported by Universidad Católica del Norte, the Center for Advanced Studies in Arid Zones (CEAZA) and the Chilean scientific association Explora Conicyt.

Kieler Forschungswerkstatt, the school laboratory of Kiel University and the Leibniz Institute for Science and Mathematics Education (IPN), is an out-of-school place of learning that focuses on various topics, such as energy, life on earth and nanotechnology. Its key functions are to support grass-roots and elite science, as well as teacher training and development. At the ozean:labor laboratory, school pupils explore the habitat of seas and oceans and get to grips with current issues in the field of marine research. The laboratory looks at the influence of people on the ocean ecosystem, using examples such as eutrophication and overfishing, and undertakes projects and activities connected with the issue of plastic waste in oceans (www.forschungs-werkstatt.de).

The **Leibniz Institute for Science and Mathematics Education** (IPN) is a nationwide research institute that studies and develops educational programmes and processes in the fields of science and mathematics.

The **Kiel cluster of excellence 'The Future Ocean'** has a globally unique approach to researching changes in the oceans – past, present and future: experts from the fields of marine science, geography, economics, medicine, mathematics, information technology, law and social sciences pool their specialist knowledge. Their research findings are incorporated into sustainable usage concepts and potential courses of action for global ocean management. The research cluster supports ozean:labor at Kieler Forschungswerkstatt.

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