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D 3.1 Plastic Pirates – Go Europe! common and harmonized standards to data sampling, processing, analysis and storage

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Date: 02.06.2023

Confidentiality: Public

Executive summary

This document has been elaborated as a deliverable (D3.1) in the framework of the Plastic Pirates EU Action describing the project's common standards and methodology to conduct the Plastic Pirates samplings and analyse the findings.

Marine litter – and especially plastic – pollution is one of the biggest and most pressing issues of the present time. Large amounts of plastic litter are being transported to the sea by rivers, brooks and streams. The Plastic Pirates – Go Europe! Citizen Science initiative aims to contribute to a better understanding of the sources, amount and type of waste in European rivers by using a citizen science approach: School classes and youth groups investigate rivers across Europe by surveying floating macrolitter and taking meso− and microplastic samples. A project booklet with sampling instructions for participants as well as a teacher booklet with background information about environmental litter pollution is available free of charge via download or shipping. The Plastic Pirates website, available in ten different languages, serves as central data entry point (https://www.plastic-pirates.eu/en/results/data-upload) where all collected data is uploaded. Subsequently, the data is analysed and verified by scientists, and made available to other scientists and scientific data bases via Open Source.

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The Plastic Pirates method was developed by the Kieler Forschungswerkstatt/Kiel Science Factory (https://www.forschungs-werkstatt.de/) and the Científicos de la Basura/Litter Scientists program (www.cientificosdelabasura.cl). In line with the Europeanisation of the initiative in 2022, the Plastic Pirates protocol and methodology is currently used and conducted in twelve European countries (Austria, Belgium, Bulgaria, Germany, Georgia, Greece, Hungary, Italy, Lithuania, Portugal, Slovenia, and Spain).

The Plastic Pirates are an initiative to show how citizen science can contribute to monitoring EU policy objectives such as Zero Pollution Action Plan for Water, Air and Soil, the Marine Strategy Framework Directive and Water Framework Directive. An obstacle to reach this objective is amongst other, the mistrust in the scientific soundness of citizen science research data by other researchers, which are mainly due to the lack of common standards regarding sampling, processing, data verification and storage.

In this common standards document, the Plastic Pirates method is outlined so that it is easily replicable and may serve as a standard for citizen science projects in the area of pollution monitoring in the maritime sector. The document outlines the scientific method in order to enhance trust in the validity of the data and excellence in citizen science. The common standards are an internationally agreed upon document, with practicable step by step explanation on how to conduct sampling, data collection, analysis and storage in a scientific method. At the same time, the common standards is a living document, which adapts to best practices in the implementation of the project.

The dissemination and exploitation of the PPEU initiative's common and harmonized standards is expected to also contribute to a further EU-wide standardization and harmonization of approaches to plastic litter monitoring and collection.

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Introduction

The Common Standards are an agreed upon instruction on the Plastic Pirates scientific method, based on the method that was developed by the Kieler Forschungswerkstatt/Kiel Science Factory (https://www.forschungs-werkstatt.de/) and the Científicos de la Basura/Litter Scientists program (www.cientificosdelabasura.cl).

The dissemination and exploitation of the PPEU initiative's common and harmonized standards is expected to contribute to a further EU-wide standardization and harmonization of approaches to plastic litter monitoring and collection.

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Setting-up a sampling

Involving scientists and citizens in the scientific set-up:

For the project implementation in a country, the objective to involve scientists as well as citizens in the scientific set- up is fourfold:

1. Civil society experiences a scientific approach first hand, which leads to greater acceptance and appreciation of the results.
2. Letting citizen formulate their own research questions may lead to a bottom up approach in citizen science, where new projects can be developed based on citizens observations.
3. Participants are motivated to contribute if they are engaged in the process beginning to end.
4. Scientists ensure science excellence.

In the case of the Plastic Pirates, teachers are involved in setting the scope of the project and children are asked to formulate their own research questions. The remainder of the set- up is predetermined.

Sampling dates

Lead: Schools/Teachers

It is recommended to conduct two sampling sessions per year, one in spring (April - June) and one in autumn (September - November). The sampling periods can last up to 3 months, with the flexibility to adjust the timing by up to two months earlier or later, taking into account country-specific factors such as extreme weather conditions or school holidays.

Ideally, a country-wide sampling period should be established to streamline the process, but researchers can also focus on a specific region based on their research question in collaboration with schools.

Participants: Schools, teacher (life sciences), 18 - 26 children per sampling.

Sampling site

Schools and teachers are responsible for identifying suitable sampling sites. They can utilize tools like Google Earth to remotely explore rivers and find appropriate locations. Involving the children in this process is encouraged.

When selecting a site, it is important to consider the specific needs of the group, such as access to the river, a vantage point, ample space, and suitable ground conditions. The availability of riverbanks may vary depending on factors like tides. The chosen sampling site should have a sufficiently large and freely accessible area along the river edge, without any hazardous banks, and a wind-protected space where the collected rubbish can be examined. It is also preferable for the river to have some flow so that the water can pass through the microplastic net.

Sampling sites can range from small streams and channels to larger rivers. Environmental considerations should be taken into account, and rules in protected areas must be followed, including respecting bird breeding periods.

If feasible and permitted, it is advisable to explore the surroundings of the chosen site before taking samples and share photos with other groups. A screenshot of the sampling site on Google Earth should be taken.

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Planning of a sampling

The planning process should consider the method, required materials, and various tasks that need to be completed. Any potential obstacles should be observed, and strategies to mitigate them should be noted.

Materials

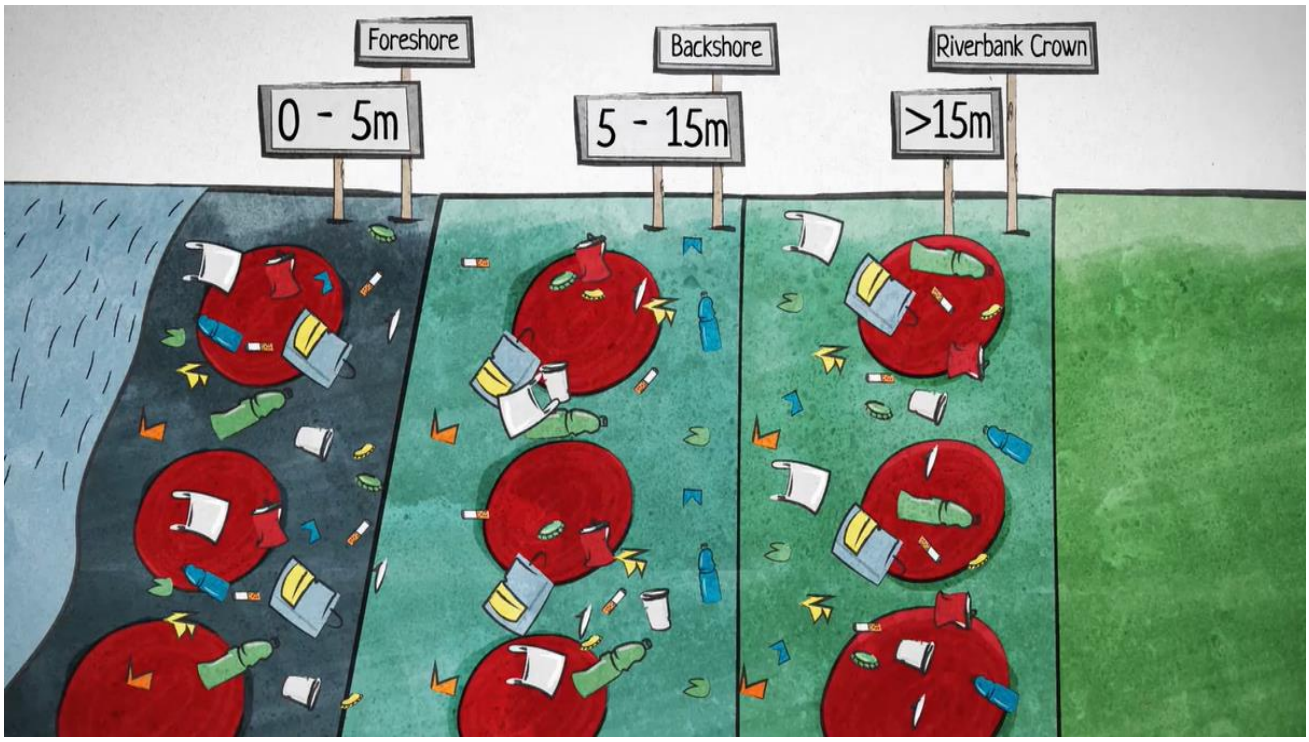
- Plastic – Pirates – Go Europe! Project Booklet
- Teaching materials and worksheets for teachers
- Cell phone with GPS
- Camera

Conducting a sampling

The objective is to establish a standardized approach to sampling that ensures the collection of comparable datasets throughout the project. The goal is to gather as many verifiable datasets as possible, promoting trust in the results.

In the Plastic Pirates project, a booklet provides detailed instructions for data collection. For the purpose of this document, "sampling" refers to all the steps conducted by participants on-site, including sampling, categorization, waste disposal, and transfer of microplastics for further analysis.

Group descriptions and objectives



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Group A: Waste on the Riverbank

Group size: 4 – 6 participants, School children under supervision of teachers / group leaders

Objective:

The objective of this group is to identify different riverbank zones and determine suitable sampling points for examining waste on the riverbank. Additionally, the group will be responsible for sorting the waste by material.

Method:

To begin, identify an appropriate area on the riverbank for sampling. Look for a spot that is easily accessible, approximately 50 meters along the river and 20 meters away from it.

Next, identify three distinct riverbank zones: the Foreshore (Zone A), the Backshore (Zone B), and the Riverbank Crown (Zone C). The Foreshore is in regular contact with the river and extends about five meters. Look for the most recent high-water mark to identify this zone. The Backshore, which encounters the river irregularly, covers the next ten meters of the riverbank. The Riverbank Crown, starting approximately 15 meters from the river, is not in contact with the river.

To establish the first transect, an artificial line that traverses all three zones, select a random location that exhibits a significant amount of waste or minimal waste. This line should extend from the edge of the Foreshore to the Riverbank Crown.

Within each zone, determine a sampling point. Place a stick in the ground at the sampling point and tie a 1.5-meter string around its bottom. Use the string to trace out a circle on the ground, and mark the circle using small stones. Repeat this process to trace the second and third circles in Zones B and C. The distance between the circles should be roughly the same. For further assistance, refer to the accompanying illustration.

Now it's time to search for waste within the first circle. Place any waste found within the circle onto a white cloth placed beside it. Remember to collect only waste items, excluding natural objects like wood or plant remnants. Focus on waste items that are at least the size of a cigarette butt (around two to three centimeters) and are located within the circle, even if other waste is in close proximity.

After collecting the waste, record the transect number, sampling point (e.g., '1A' indicates transect 1, Foreshore sampling point), and the name of your school or organization on a sheet of paper. Place this sheet of paper next to the cloth containing the waste and capture a clear photo of both the sheet and the spread-out waste on the cloth. Ensure that individual waste pieces are easily visible, without overlap or interference from other objects. Verify if the waste can be identified using the accompanying sheet.

Count the collected waste items and sort them according to their materials. Record your findings in the booklet provided.

Repeat the entire procedure for the two remaining circles and establish a second and third transect. This repetition is essential to generate reliable data. Maintain consistent circle levels across all transects. Ideally, maintain a minimum distance of 20 meters between transects, as long as sufficient space is available.

Remember to capture a photo at each sampling point, even if no waste is found (photo of the sheet of paper with an empty cloth). This ensures that all results can be included in the scientific study.

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If a substantial amount of waste is found, it is recommended to pack it into bags after completing the last circle. Counting and further analysis of this waste can be conducted at school or in the group's designated room. To avoid mixing up waste from different sampling points, label each bag with the corresponding transect and sampling point number (e.g., '1A').

Materials:

- A straight stick, approx. 50cm long
- Piece of string, 1.5m long
- Pebbles or similar objects to mark out a circle
- Camera or smartphone
- Paper and a thick felt-tip pen
- A white cloth
- Tape measure
- 9 bags (for gathering the waste if this is to be counted later at the school/in the group's room)
- Work gloves



Group B: Variety of waste on the riverbank

Group size: 6 – 8 participants

Objective:

The objective of this group is to establish a waste-sorting station, categorize the pieces of waste along the riverbank, and calculate the proportion of single-use plastic.

Method:

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Begin by finding a suitable location for the waste-sorting station, which should be positioned at least 50 meters away from Group A and sheltered from wind. This station will serve as the area for sorting, counting, and documenting the collected waste. Assign at least two participants to handle the sorting and documentation tasks, with additional people required if a significant amount of waste is found. The sorters should familiarize themselves with the waste categories and set up the station accordingly. Label the categories on a piece of adhesive tape and attach it to the canvas. Place separate buckets for waste items that could easily fly away, such as plastic packaging and plastic bags, to prevent them from mixing with other waste. If a large amount of waste doesn't fit into any existing category, you can create an additional category.

The remaining participants should take buckets and search for waste, ensuring they avoid the area designated for Group A (requiring approximately 50 meters of space along the riverbank). Maintain a distance no greater than 20 meters from the river while searching. Before starting, mark the 20-meter point and walk alongside each other, maintaining a relatively consistent distance.

Collect all the waste found during the search. Exercise caution when handling sharp objects or hygiene items and always use work gloves when picking them up. Shake out sandy or dirty waste items thoroughly. Once a bucket is full, bring it to the waste-sorting station, where the sorting experts will assist in separating the waste into the appropriate categories. Return to the sorting station no later than one hour or when no further waste can be found.

Measure the length of the riverbank covered using a measuring tape or a string. If you have walked a considerable distance, you can measure 50 or 100 meters of string and use it as a reference for measuring the distance. Record this value in the data table.

Count the first pile of waste and record the results in the data table. If no waste is found in a particular category, enter zero in the table. Spread out the waste without overlapping and take a photo of the waste together with the corresponding category name. Check the quality of the photo and take multiple photos if a significant amount of waste is found in a specific category.

Repeat the same procedure for all the waste categories.

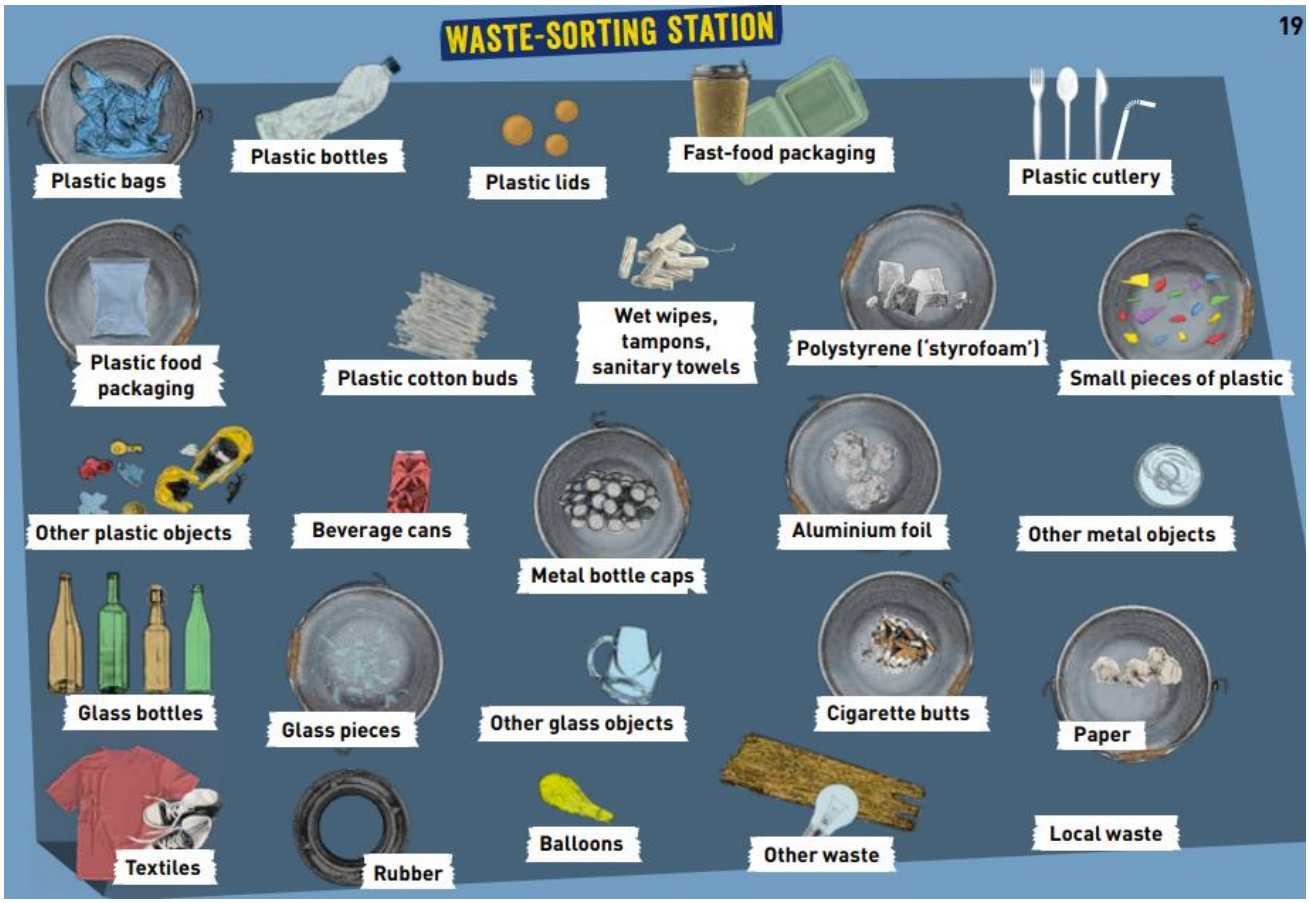
Weigh the plastic waste separately from other waste items. Then weigh all the waste together, including the plastic waste, and record the results in the table. You can use a waste bag for weighing purposes. Once completed, dispose of the waste appropriately.

Calculate the total number of waste items in each category and determine the percentage that each category represents. Utilize the provided formula to calculate the proportion of single-use plastic. Record your results and discuss effective measures to reduce waste in each category, such as the prohibition of single-use plastic.

It is important to collect and document all types of waste, not just single-use plastic, to generate reliable data on all waste categories. When counting the waste, consider loosely connected items or those found within other containers as individual pieces. For example, if a plastic bag contains other waste, empty the bag and record each piece separately (remember to wear gloves). Objects that are firmly connected, such as a glass bottle with a screwed-on lid, or tightly wrapped items like fishing nets, should be counted as one piece of waste. The waste category is determined by the larger object.

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Materials:

- Buckets, bags or other containers for collecting and sorting the waste (the more the better)
- Canvas, approx. 5m by 2m - Fabric adhesive tape and thick felt-tip pen
- String, at least 10m long, the longer the better (for measuring the area)
- Tape measure
- Camera or smartphone
- Waste bags for removing the waste
- Work gloves
- Scale, ideally a luggage scale

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Group C: Floating Waste

Group size: 6 – 8

Objective:

The objective of this group is to sample with the net, observe floating waste, and count and classify large floating waste and larger microplastics.

Method:

To begin, find a suitable location for casting your sampling net, such as a jetty, a small bridge, or an accessible spot on the riverbank.

Cast the net with the opening facing the opposite direction of the river's current. Ensure that the net is stabilized, allowing the river water to flow through the opening. Take note of the current time and let the net remain in the river for 60 minutes. Optionally, secure the net to a bridge railing or a bollard. Capture a photo of the net floating in the river, as it will aid in data interpretation.

Measure the flow speed of the river adjacent to the net's location. Use a measuring tape to mark off 20 meters along a straight stretch of the riverbank. Establish a starting point at zero meters and a finishing point at 20 meters.

Take one of the sticks and lay or toss it at the starting point, aligning it with the approximate location of the net. Start the stopwatch as the stick passes the finishing point and stop it when the stick reaches that point. Record the time in seconds in a results table.

Repeat this measurement with the remaining two sticks and complete the table. Calculate the average time and use the provided formula to determine the flow speed of the river.

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Observing floating items, find a vantage point that allows for monitoring of both the net and floating waste. Estimate the overall width of the river and the portion that can be observed. Use objects in the water, such as buoys or rocks, as reference points. If on a bridge, note the GPS coordinates to determine the river's width. Record both values.

Keep a vigilant eye for floating waste and attempt to capture photos of the objects. Inform the other group members, working together to identify the objects and determine the materials they are made of. Do not count waste that is stuck and not drifting. Document your observations in a list and continue observing for at least 30 minutes.

Once the designated period has elapsed, record the end time in the results table. Retrieve the net after 60 minutes and note the end time as well.

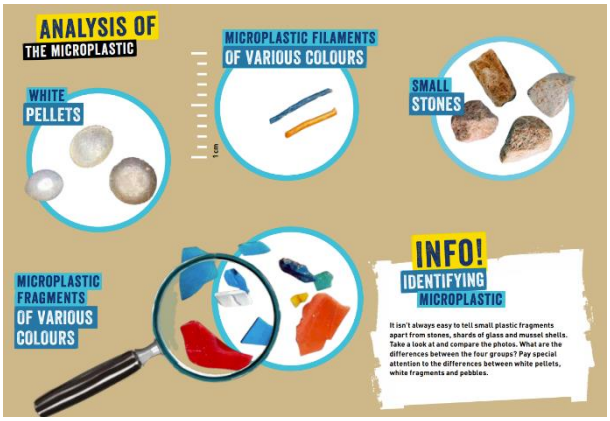
Seal the net to prevent it from opening again and bring it to a dry location, such as the school or group room, to dry.

Calculation of microplastics per 1,000 liters of river water:

Calculate the number of microplastic fragments per cubic meter of river water using the following factors:

- Flow speed in meters per second.
- Area of the net opening: Measure the internal opening of your sampling net in meters. Note the values for side a and side b. Note: Only a portion of the net is submerged in the water, typically around 9 to 11 centimeters. Use a value of 0.09 meters for side b. Calculate the surface area of the opening in square meters: a × b = ... m^2.
- Length of time the net was cast, in seconds.

Sampling net:



Once the net and its contents are dry, carefully open it and empty the entire contents onto a tray. Ensure that all materials are removed from the net to avoid leaving behind small pieces. Examine the contents for microplastics using a dissecting microscope or a magnifying glass and sort the plastic pieces into fragments and pellets. Document the results. Place all the contents, including microplastics and other objects, into a tightly sealable bag labeled with the name of the school or organization and the group name. The teacher or group leader will return this bag, along with the net, to scientific institutions to confirm the results and further analyze the collected samples.

Note: Please send the sample to the scientific institutions even if no microplastic was found in order to contribute to the overall understanding of the river's condition.

Materials:

- Sampling net
- 2 empty, plastic waterbottles
- Instructions stabilize sampling net
- String/rope (to cast the net)

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- Stopwatch/smartphone
- Tape measure or string, 20m long
- Three sticks of similar size (may be found at the sampling site)



Group D: Team of Reporters

Objective:

The objectives of this groups are to document the sampling process with photos or a short video, seek out and identify sources of waste, and estimate the effects of weather conditions. Securing data and photographic evidence is crucial for accurate analysis and reporting.

Method:

To begin, search the surrounding area for potential sources of waste and capture photographic evidence. Pay attention to overflowing bins by the river, nearby overflowing bins, bulk waste, scrapyards, diverted waste water, gratings, fishing equipment, and very light plastic objects that could be easily carried by wind. Consider whether any significant one-time events, such as storms or festivals, could be responsible for the waste accumulation.

Next, gather as a group and discuss any severe weather conditions that have occurred in recent weeks. Make a note of these conditions as they may have influenced the presence and distribution of waste in the area.

Collect the data from groups A, B, C, and any additional groups involved in the research. Enter all the collected values into the designated tables for comprehensive analysis and comparison. It is also valuable to conduct interviews with the other groups to understand their research methods, objectives, and any challenges they encountered during the sampling process. Document their responses in the results table.

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Engage with the other groups to learn about the types of waste they have found thus far and discuss potential sources of origin. Capture photographic evidence of the waste to support your observations and findings.

Take a group photo, if possible using a self-timer, and include the name of your school or organization and the name of the river in the photo. With consent, this photo, along with your group name, can be shared on the interactive map at plasticpirates.eu/en/results/map for others to view.

Remember to record the date of the sampling and take note of the coordinates (in decimal degrees) of group C's sampling location using tools like Google Maps. Additionally, if you come across any animals or plants that have been affected by the waste, make a note of it and capture photographic evidence.

Materials:

- Camera or smartphone
- A notepad and pen



Extra Group: Microplastic on the riverbank (optional if there is a sandy beach)

Objective:

The objectives of the extra group are to determine the high-water mark, trace a transect along the sandy beach, separate microplastic from sand through filtering, and identify and classify the microplastic.

Method:

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To begin, locate the high-water mark where the wet and dry sand meet. If you are unable to find this line, take samples within the first meter of the riverbank as an alternative. Once the high-water mark is identified, lay out a 20-meter-long string along this line and mark three points parallel to the river: one at the start, one in the middle, and one at the end of the string.

At each of these marked points, measure out a 50 centimeter by 50 centimeter square and mark it out in the sand. Begin with the first square and remove any larger natural objects such as stones, algae, plants, and wood. Use a spade to dig approximately two centimeters into the sand within the square and place the excavated sand onto a tray.

Next, filter the sand on the tray using a sampling sieve. Anything left behind in the sieve should be collected on another tray. If the sand is damp, it is advisable to avoid filtering it on the beach and instead pour it into a bag, which should be labeled with the sampling point number. Close the bag securely and transport it back to your school or group room. Once there, leave the sand to dry in appropriately labeled trays, and once dry, filter it using the sampling sieve. Collect any remaining contents of the sieve onto another tray.

Examine the contents of the tray closely and sort the microplastic into one corner. Count the plastic fragments and pellets and record the results in the provided table. Employ the same method used by group C to identify microplastic.

Once you have counted all the microplastic pieces and entered the data into the table, label a bag with the name of your school or organization, the sampling point number, and pour the entire contents of the tray into the bag, including the sand and not just the larger microplastic. Seal the bag securely. Repeat this procedure for the second and third samples, ensuring that the samples are not mixed but instead placed in separate labeled bags.

To calculate the sampling area, determine the size of your sampling squares in square meters by multiplying the length of side a by the length of side b. Use this information to calculate the number of pieces of larger microplastic for 1 square meter of each sampling point. Divide the number of larger microplastic fragments by the area of the sampling point in square meters. Finally, calculate the average of the three sampling points to determine the amount of larger microplastic per square meter of river beach that was found.

Materials:

- Sampling sieve, mesh width: 1 mm
- Piece of string, 20m long
- Small spade or tub to dig out the sand
- Three sealable bags to hold the samples
- Trays

Overall recommendation:

Tip for scientific institution accompanying the sampling: Rapid communication and documentation of the conversations between the schools/ teachers and the research institute proved to be crucial to obtain missing data and clarify questions related to the respective data set, for example why annotated litter objects did not show up in photos.

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Collecting the data

In citizen science projects, data is prone to be imperfect. However, excellence can be reached with a large amount of verified data. Therefore, the aim is to get as many data sets as possible.

In case of the Plastic Pirates, the teachers and children prepare the sample sets, and teachers or the students upload them to the Plastic Pirates website using a prepared template to unify the data. Scientists may accompany this step to ensure that no dataset is lost.

Data Upload

Lead: Teachers / group leaders with support from trained scientists

When findings are evaluated, teacher, students or group leaders upload the key data, as well as photos, to the following website: plastic-pirates.eu/de/results/data-upload

They are asked to think about a name for the group, which is used when uploading the results so that other project groups can compare their findings. To do so, they go to the website and fill in the data upload form. The reporter team, group D, will take on this task together with the teacher. For the scientific evaluation and interpretation, the scientists will also need the original data. Hence, they are also asked to upload a scan or photo of the completed results tables / pages.

Overall recommendation:

It is recommended that scientists accompany the process. They should be available to assist with data upload, sometimes receive data per email and upload themselves. Sometimes datasets need to be split up (one method was repeated, sampling at two different dates, at two different places, or similar) to ease the process.

1.1. Material

- Booklet
- Photos
- Computer
- Internet access

Processing: data consolidation and verification

Objective:

Once the data is collected and uploaded in a unified manner, the samples are processed. The aim is to have common standards to verify the data in order to receive respectable and comparable data. This part is usually conducted by trained scientists. If for example schools have equipped laboratories, processing may be conducted by students under supervision of science teachers or trained personnel.

The goal of the Plastic Pirates data verification is to collect data and enable re-usability for further analysis. This includes a) be able to have a data table with all verified data at the end of a campaign that is self-explicatory and could for example also be used by external researchers, and to b) be also able to detail why datasets had to be excluded and how many datasets were excluded for which reason. The latter is important

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to improve processes in subsequent campaigns of the Plastic Pirates and also helps to find acceptance of the citizen science data within the scientific community. As there are different subsamplings the participants conduct at the river, each step of the data verification process corresponds to an individual subsampling apart from the general verification of the metadata.

In general, the verification process should follow up the initial data check, where school teachers should be contacted as quick as possible if data is missing (otherwise it becomes likely that data are lost).

In case of the Plastic Pirates data verification is first and foremost conducted by trained scientists. Scientists' main task is to verify time critically that all important information, photos, samples, etc. are available the team.

Following an outlined scheme, Scientists verify the data samples that were uploaded by the schools.

Method

Lead: Trained scientist, School children under the supervision of trained scientists.

The first step is a quick data check. Review of the submitted dataset for usability.

Rapid assessment of obvious missing information or potential errors (missing data sheets, metadata, samples, etc.), and the "data verification" as the step investigating in depth whether a dataset has research data quality and potentially identify further questions that need clarification. The steps can be done independently or could ideally be done in one step.

In a first step, scientists need to access the backend of the Plastic Pirates website and look for new entries. Check if all necessary information is available and take note of it in the data table. Contact the teachers for this information, if it is not available. Verify that:

- Data is readable
- Sampling coordinates are accurate (<50m)
- Group A, B: Photos are available
- Group C: Sample and data from group using the net are available

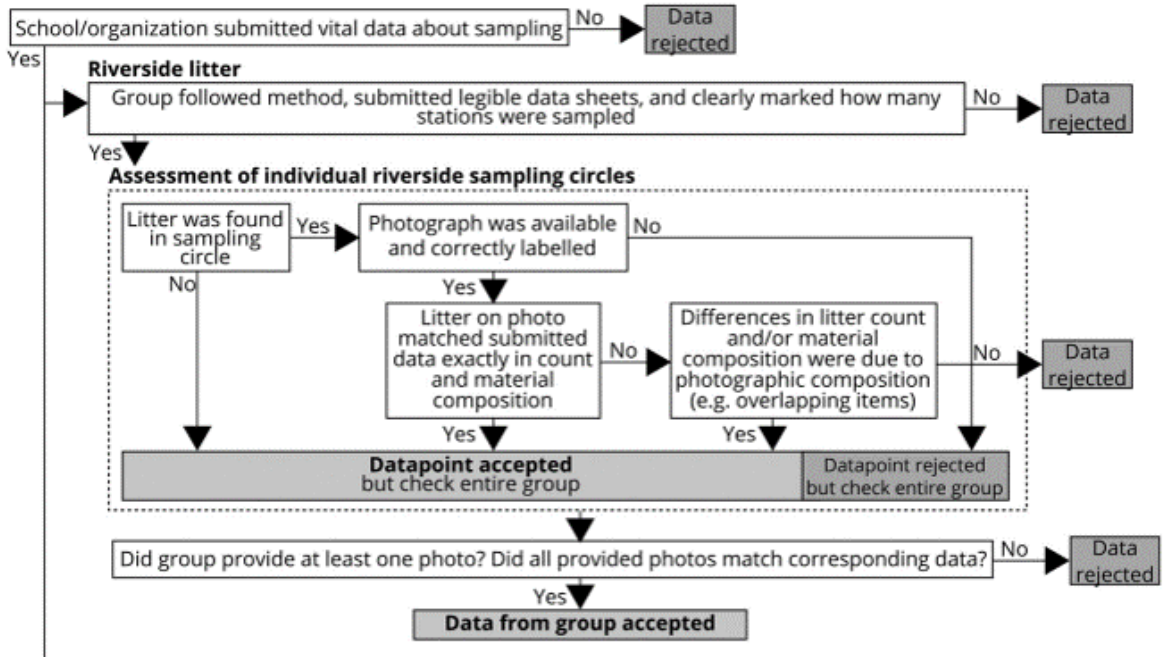
Note any difficulties (e.g. flow velocity very low, too much waste).

Tip: this step has a high workload and is time critical, directly following the sampling campaign.

Step by step flowchart for accepting or rejecting data (insert flowchart):

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Researchers should use the corresponding data table "Data verification sheet of Plastic Pirates data v27-01-23.xlsx" (see Annex) to enter the data from your Plastic Pirates campaign. Enter the basic information for each dataset (up to *SamplingInstitution*), and subsequently the steps below are necessary for data verification.

Sampling attempted

Indicate in the field "*SamplingAttempted*" whether a group actually tried to sample (enter 1) or had to cancel their trip of aborted the missions (enter 0). Detail in "*SamplingAttemptedComment*" why this happened (for example illness, bad weather, no transport available, COVID, etc.). If a 0 was entered the following steps don't have to be considered.

1. **Verification of metadata**

Revise if an entire dataset of a participating team can be used or not. The evaluation of individual subsamplings follows afterwards. However, if this step cannot be passed, all data of the groups are likely unusable. The main question is whether all relevant metadata exists.

Copy in the corresponding table under "*DatasetReasonDisqualified*" all of the following reasons that apply that would lead to an exclusion of a dataset or add any other reason here:

- The sampling data (exact day) is unknown.
- The sampling coordinates are unknown or not precise enough (within 50 m of a river) Leave a comment detailing what was wrong if possible under "*DatasetReasonDisqualfiedComment*". Indicate in field *DatasetQualified* whether the metadata are all accurate. 1 = Yes, 0 = No, dataset is disqualified. Subsequently fill out the next data fields.

2. **Verification of riverside litter data, Group A**

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This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 10108882.

This group has the most strict and well-documented verification process. If there are no important reasons against this, we advise to follow these steps precisely so that all partners have verified the data exactly the same way. To start, indicate whether the group attempted to do this subsampling or not in field "*RiversideLitterCircles_AttemptedSampling*". 1 = Yes, 0 = No, ? = Unknown. Assess whether there are reasons that would lead to exclusion of dataset, copy all that apply in field "*RiversideLitterCircles_DisqualifiedReason*" (also see Supplemental material S2-2 in Kiessling et al. 2019):

- Method not followed (e.g. litter outside the circles was sampled, the circles were larger or smaller than the indicated size, another area was sampled and not the circles, etc.)
- The data submitted was illegible
- Unclear how many stations were actually sampled (be extra careful here! Sometimes data fields are left empty. Make sure you know whether this is because no litter was found or the station was not sampled!)
- Litter was found but not a single photograph available (there should be at least one photo out of the nine sampling stations that were surveyed to assess the quality of the dataset. Exception: if no litter was found in all of the sampling circles no photos are needed).

This is also the time to compare all available photos to the datasheet entries of this group. For this use the second sheet 'Group A data verification' in Data verification sheet of Plastic Pirates data v27-01- 23.xlsx. Have the original data of each circle of each group entered as a separate row (in the columns labelled "*OriginalResults_*"). Open a picture corresponding to a sampling circle. Then fill out the columns starting with "*DataVerification_*". Afterwards compare these columns and based on the following fill out data field "*DataVerification_AcceptReject*".

- Are the data the same? Then add "Accept - photo and data perfect match" in the column.
- Do data match approximately? This often is a bit subjective. Please carefully read the examples in Supplement S2-2 in Kiessling et al. 2019. Oftentimes items are hard to recognize or overlap. This is no reason to exclude dataset. Just keep note of what the reason was precisely to be able to verify data only approximately. For example, enter "*Litter items overlap*", "Composition of litter items hard to assess", "*Litter items possibly broke apart*" or something corresponding in the datafield.
- How can the difference be explained? Afterwards input "Accept – photo and data match approximately into data field" "*DataVerification_AcceptReject*".
- Are data and photos not the same and the difference is not due to the reasons listed above? Then enter "Reject - photo does not reflect data"
- If all was good, then enter the accepted data in the columns starting with "Accepted_".

If there was one "Reject" among the nine circles, the entire dataset is disqualified and the reason "groups with inexplicable differences between litter counts and material composition on photographs upon comparison to submitted data sheets" should be input into column "*RiversideLitterCircles_DisqualifiedReason*" on the first sheet of Data verification sheet of Plastic Pirates. Afterwards put a 0 in field "*RiversideLitterCircles_Qualified*" if dataset had to be rejected and a 1 if it could be accepted. Fill out the following columns which are basically the summary of individual stations sampled by this group (i.e. enter how many stations have been sampled, in how many litter was found, how much paper etc. was found in total and so on).

3. Verification of riverside litter data, Group B

Funded by
the European Union

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 10108882.

This group has a more relaxed verification workflow as we so far have only been interested in total litter quantities per category across the entire country (and therefore minor discrepancies are unlikely to substantially influence the results). This may be different and the protocol may be adapted for other research questions that split a dataset (e.g. if comparisons should be made between regions, rivers and so on). Input into the field "*RiversideWasteVariety_AttemptedSampling*" if this subsampling was attempted or not. Afterwards include all of the following or any other reasons that would lead to rejection of dataset in field "*RiversideWasteVariety_DisqualifiedReason*":

- Method not followed (e.g. litter was sampled far inland, litter was weighted and not counted, litter was only partially quantified, other litter categories were used and could not be reassigned to reflect our categories)
- The data submitted was illegible
- Unexplainable mismatch between litter on photos and data sheets

For the latter point compare photos for this subsampling to the data sheet. Rather than counting individual items (often not possible) try to identify errors that were made and track those in the sheet 'Group B data verification' in Data verification sheet of Plastic Pirates data v27-01-23.xlsx in column Type of error made. Common errors may be that items with a similar use were misclassified (e.g. packaging of food misclassified as snack packaging, paper bags of fast food chains misclassified as plastic fast food packaging and so on). Also track how often items occurred in photos but are not reflected in data sheets as a type of error. If possible also roughly quantify the number of items affected by these errors and keep track of those in column Approximate number of items affected. In the end it would be great if we can say something like "A total of x% of groups misclassified some litter items and the overall items affected by misclassifications are approximately x%". Go back to first sheet and fill out field "*RiversideWasteVariety_Qualified*" and subsequently fill out all following fields with the actual accepted data of group B.

4. Verification of riverside litter data, Group D reporter team

For this group only cross-verification with other groups is possible. First mark again if the sampling was attempted. Then check the photos of group A and B (if existing) and compare to the evaluation of the reporter team. Do you think that their main litter sources marked in the data table correspond to the pictures of the other groups? If not, potentially disqualify the group and enter the reason why this was necessary in field "*ReporterTeam_DisqualifiedReason*". Afterwards, enter data by schoolchildren in the following fields. Also check if this group reported any big problems that the other groups encountered and, if necessary, re-evaluate whether these groups would need to be excluded with these new insights.

5. Verification of riverside litter data, additional group investigating sediments

We did so far not analyse any data or samples of this group. Mark in the datasheet whether this group was attempted and any further comments.

6. Verification of floating litter data, Group C floating macroplastics

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Indicate whether this subsampling was attempted in field "*FloatingMicro_AttemptedSampling*". Afterwards indicate reasons if this subgroup was excluded from analysis in field "*FloatingMicro_DisqualifiedReason*". Reasons may be

1. Litter was not quantified
2. It remained unknown for how long the river was observed or the observation time was < 30 minutes
3. It was unknown whether all litter really floated by the observation post or was stuck to the riverside or any other obstacle in the rivercourse.

Regarding the latter reason, sometimes the participants counted litter stuck at obstacles or at the riverside. This was usually the case when a large quantity of items was observed, so we had asked school teachers for confirmation of many floating litter items if more than 10 litter items were noted in the datasheet. Only if they indicated something along the lines of "Yes, there was much litter and it was actually floating" we considered datasets with > 10 items. Also see details in Kiessling et al. 2021, 2.6.1. Fill out the remaining data columns associated with this group.

7. Verification of floating litter data, Group C floating microplastics

1. All samples received from schools need to be registered and checked. If samples are wet, please dry them, e.g. possibly at 50°C in drying oven until they are dry, otherwise they can get fungi.
2. Check if the samples are qualified for further analysis. Sampling time needs to be 60 min or more. Reasons for disqualifications are:
    a. Sampling period unknown or < 60 min
    b. students used other net
    c. coordinates are > 50 m away from the river
    d. sample bag is broken
    e. other methods than our described method in the sampling booklet were used.
3. Conduct a visual sorting with a dissecting microscope (magnification around 6.4) and register suspicious particles (sometimes 0 - 80 particles/sample).
4. Checking the whole sample for unlimited amount of time.
5. If students did a pre-selection of suspicious particles, please check the whole sample anyway.
6. Each particle gets an ID and we register the colour and type of the particle (types: Styrofoam, hard fragment, soft fragment, pellet, monofilament, film, other microlitter).
7. Measure the longest site of each particle before FTIR measurement. Particles < 1mm will be excluded from further measurements. We are using the following size categories for further analyses: > 1mm, < 5mm Micro, > 5mm, < 25mm Meso, > 25mm Macro.
8. FTIR-measurement: Clean each particle if possible with ethanol before FTIR measurement. Conduct 3 measurements with FTIR. If 3 times the probability score is > 0.7 for a certain plastic type, we count this particle as plastic. Sometimes we are measuring particles again, e.g. when the score was 2 times > 0.7 and 1 time close to 0.7.

8. Verification of floating litter data, Group C flow velocity

So far, no verification process for this data is established. Two things can be done (Kiessling et al. 2021, 2.6.1): "The measurement of flow velocity of each group was considered valid if

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1. the average flow velocity was between 0.1 and 1.0 m s−1 (a flow velocity < 0.1 m s−1 frequently indicated that the sticks floated in circles or got stuck repeatedly, while a flow velocity > 1.0 m s−1 usually resulted from an obvious mistiming or individual fast measurements), and
2. if the standard deviation from replicates divided by the average of the three measurements was <0.3". The flow velocity was used to roughly estimate the amount of microplastics per volume unit (1000 litre of river water) across the entire study area and was not used to calculate this value for each individual sample.

Recommendation: each particle needs its own container!

9. Storage of findings

Currently, each research institute individually organizes the storage of material. The aim is to agree on a timeframe and uniform manner to store materials in order to ensure future access.

Materials

- Data verification sheet of Plastic Pirates data v27-01- 23.xlsx.
- Computer with access to internet
- Supplement S2-2 in Kiessling et al. 2019
- dissecting microscope (magnification around 6.4)
- Ethanol
- Fourier-transform infrared spectroscopy (FTIR)

Data management

Objective:

Data management is critical. The following common standards collectively support the Plastic Pirates project's goals of enhancing the discoverability, accessibility, interoperability, and reusability of its data and research outputs. By following these standards, the project contributes to a more open and collaborative scientific community, fostering better understanding and addressing plastic pollution in rivers and waterways across Europe in line with FAIR principles.

In case of the Plastic Pirates, all data from citizen scientists is organized in an ordered spreadsheet. At the end of this phase, there isno need to look at paper datasheets.

Method

Findability and metadata: Persistent identifiers, such as DOIs, are assigned to the datasets to ensure long-term access. Rich metadata is provided, following standards like the Dublin Core Metadata Element Set and DataCite Metadata Schema. Search keywords are included to optimize discoverability, and machine-readable formats like XML or JSON are used for easy indexing and harvesting by search engines and discovery tools.

Accessibility and repositories: The project utilizes trusted repositories like Zenodo to deposit and openly share the data. These repositories provide standardized access protocols, ensuring the data is accessible through free and open channels. The data is made openly available, and exceptions or embargoes are clearly stated with justifications.

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Interoperability: Established data and metadata vocabularies, such as the Dublin Core Metadata Initiative, are followed to enable data exchange and re-use across disciplines. Mappings to commonly used ontologies are provided, and qualified references to other datasets are included to enhance the usefulness and context of the data.

Data re-use: Comprehensive documentation is provided, including methodology, codebooks, and data cleaning processes, to facilitate data re-use and validate analysis. The data is made freely available and licensed using standard reuse licenses like Open Data Licensing. Efforts are made to ensure the long-term accessibility and usability of the data, either through third-party repositories or European databases.

Resource allocation: Costs associated with data management activities are carefully allocated from the Horizon Europe grant. Subcontracting and utilizing skilled experts from the Plastic Pirates community are employed to support data cleaning, storage, preservation, and accessibility. Open source repositories are chosen to minimize costs.

Data security: Provisions are in place to ensure data security throughout its lifecycle. Regular backup procedures, secure storage/archiving in trusted repositories, and encryption during data transfer are implemented to protect the data from loss or unauthorized access.

Ethics and legal considerations: Informed consent is obtained from participants regarding data sharing and long-term preservation. The terms of participation outline the conditions and rights associated with data sharing, including copyright and personal rights. Data protection regulations are adhered to, and personal data is handled in accordance with privacy policies to maintain participant privacy.

Material

Software: The project employs spreadsheet software, such as Microsoft Excel, for storing and organizing the collected data. Additionally, data analysis and visualization tools may be utilized to visualise the data.

Products: The primary product generated by the project is a dataset containing field observations, photographs, and measurements of plastic litter. This dataset is stored in spreadsheet format or similar and is accompanied by metadata. The data is made available through trusted repositories like Zenodo or EmodNet to ensure long-term accessibility and reusability.

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Annex

Annex 1: **Data Verfication sheet of Plastic Pirates**

Note that the Data Verification sheet of the Plastic Pirates is a document based on best practices.

Find below an indication of the data sheet. When implmenting the Plastic Pirate initiative, always refer to the latest version of the document. Link to sharepoint or contact the project cooridnators.

Worksheet: Plastic Pirates data and verification

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y
1	DatasetID	CountryResponsible	ResearchInstituteResponsible	PersonResponsible	PersonContact	GeneralCommentDataset	SamplingCampaign	SamplingYear	SamplingTeamName	SamplingInstitution	SamplingAttempted	SamplingAttemptedComment	DatasetReasonDisqualified	DatasetReasonDisqualifiedComment	DatasetQualified	SamplingOnlineOnWebsite	SamplingDate	SamplingCoordinatesLatitude	SamplingCoordinatesLongitude	SamplingPlace	SamplingRegion	SamplingRiver	SamplingRiver	SamplingParticipants	SamplingComment
2	Supply a unique I	Country resp	Research in	Person resp	Conctact of responsible		Indicate here to which Pl		Self-given na	Institution the	citizen scientists belong to, usually a school				1 = Metadat	1 = dataset	Indicate dat	Indicate the	Indicate the	Closest plac	Administrati	Name of rive	Name of rive	Enter the nu	Any other g
3																									
4																									
5																									

	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB
1	RiversideLitterCirclesAttemptedSampling	RiversideLitterCirclesDisqualifiedReason	RiversideLitterCirclesQualified	RiversideLitterCirclesResultsNumberOfStationsSampled	LitterCirclesResultsNumberOfStationsWithLitterFinding	RiversideLitterCirclesResultsPaperTotal	RiversideLitterCirclesResultsCigaretesTotal	RiversideLitterCirclesResultsPlasticTotal	RiversideLitterCirclesResultsMetalTotal	RiversideLitterCirclesResultsGlassTotal	RiversideLitterCirclesResultsFoodLeftoverTotal	RiversideLitterCirclesResultsOtherTotal	RiversideLitterCirclesResultsOverallTotal	RiversideLitterCirclesResultsAveragePerM2	RiversideLitterCirclesResultsComment	RiversideWasteVariety_AttemptedSampling	RiversideWasteVariety_DisqualifiedReason	RiversideWasteVariety_Qualified	RiversideWasteVariety_ResultsPlasticBags	RiversideWasteVariety_ResultsPlasticBottles	RiversideWasteVariety_ResultsPlasticLids	RiversideWasteVariety_ResultsTakeawayFastFood	RiversideWasteVariety_ResultsPlasticCutleryPlates	RiversideWasteVariety_ResultsPlasticPackagingSweets	RiversideWasteVariety_ResultsCottonBuds	WasteVariety_ResultsWetWipesSanitaryProducts	RiversideWasteVariety_ResultsPolystyrene	RiversideWasteVariety_ResultsSingleUsePlasticTotal	WasteVariety_ResultsSmallPlasticPieces<2.5cm
2	1 = Group attemtped		1 = yes, 0	Indicate hc	Indicate in how many of those stations litter was found											1 = Group attemtped		1 = yes, 0	= no										
3																													
4																													
5																													

	BC	BD	BE	BF	BG	BH	BI	BJ	BK	BL	BM	BN	BO	BP	BQ	BR	BS	BT	BU	BV	BW	BX	BY	BZ	CA	CB	CC	CD
1	WasteVariety_ResultsOtherUnidentifiablePlastic	RiversideWasteVariety_ResultsMetalBeverageCans	RiversideWasteVariety_ResultsBottleCaps	RiversideWasteVariety_ResultsAluminiumFoil	RiversideWasteVariety_ResultsOtherUnidentifiableMetal	RiversideWasteVariety_ResultsGlassBottles	RiversideWasteVariety_ResultsGlassPieces	RiversideWasteVariety_ResultsOtherUnidentifiableGlass	RiversideWasteVariety_ResultsCigaretteButts	RiversideWasteVariety_ResultsPaper	RiversideWasteVariety_ResultsTextiles	RiversideWasteVariety_ResultsRubber	RiversideWasteVariety_ResultsBalloons	WasteVariety_ResultsOtherUnidentifiableWaste	RiversideWasteVariety_ResultsLocalWaste	RiversideWasteVariety_ResultsTotalNumber(incl.SUP)	WasteVariety_ResultsProportionSingleUsePlastic	WasteVariety_ResultsLengthOfRiverbankSearchedM	RiversideWasteVariety_ResultsWeightPlasticWasteKG	RiversideWasteVariety_ResultsWeightAllWasteKG	RiversideWasteVariety_ResultsResultComment	RiversideWasteVariety_ResultsResultComment	ReporterTeam_AttemptedSampling	ReporterTeam_DisqualifiedReason	ReporterTeam_Qualified	ReporterTeam_Results_SourceResidents	ReporterTeam_Results_SourceVisitors	ReporterTeam_Results_SourceFlyTippers
2																								1 = Group attemtped this		1 = yes, 0 =	Enter "Yes",	Enter "Yes",	Enter "Yes",
3																												
4																												
5																												

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	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CQ	CR	CS	CT	CU	CV	CW	CX	CY	CZ	DA	DB	DC
1	ReporterTeam_Results_SourceIndustry	ReporterTeam_Results_SourceAgriculture	ReporterTeam_Results_SourceShipping	ReporterTeam_Results_SourceFishing	ReporterTeam_Results_Weather_Rain	ReporterTeam_Results_Weather_Storm	ReporterTeam_Results_Weather_Heat	ReporterTeam_Results_Weather_Heat	ReporterTeam_Results_Problems_GroupA	ReporterTeam_Results_Problems_GroupB	ReporterTeam_Results_Problems_GroupC	ReporterTeam_Results_Problems_ExtraGroup	ReporterTeam_Results_Problems_BiggestProblems	ExtraGroup_AttemptedSampling	ExtraGroupComment	FloatingMacro_AttemptedSampling	FloatingMacro_DisqualifiedReason	FloatingMacro_Qualified	FloatingMacro_ObservationTimeInMinutes	FloatingMacro_AmountOfFloatingMacrolitter	FloatingMacro_Comment	FloatingMicro_AttemptedSampling	FloatingMicro_DisqualifiedReason	FloatingMicro_Qualified	FloatingMicro_SamplingTimeInMinutes
2	Enter "Yes",	Enter "Yes",	Enter "Yes",	Enter "Yes",	Enter "Yes"	Enter "Yes"	Enter "Yes" or "No"		Enter "No pr	Enter "No pr	Enter "No pr	Enter "No pr	Transcribe text entered by schoolchild			1 = Group attemtped this		1 = yes, 0 = no				1 = Group attemtped this		1 = yes, 0 = no	
3																									
4																									
5																									

	DB	DC	DD	DE	DF	DG	DH	DI	DJ	DK	DL	DM
1	FloatingMicro_Qualified	FloatingMicro_SamplingTimeInMinutes	FloatingMicro_AmountOfVERIFIEDMicroplastics	FloatingMicro_AmountOfVERIFIEDMesoplastics	FloatingMicro_Comment	FloatingFlowVelocity_AttemptedSampling	FloatingFlowVelocity_DisqualifiedReason	FloatingFlowVelocity_Qualified	FloatingFlowVelocity_FirstStick	FloatingFlowVelocity_SecondStick	FloatingFlowVelocity_ThirdStick	FloatingFlowVelocity_Comment
2	1 = yes, 0 = no		Indicate how	Indicate how many meso		1 = Group attemtped this		1 = yes, 0 = no				
3												
4												
5												

Worksheet: Group A data verification

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	DatasetID	Transect	Station	OriginalResults_Paper	OriginalResults_Cigarettes	OriginalResults_Plastic	OriginalResults_Metal	OriginalResults_Glas	OriginalResults_Foodleftover	OriginalResults_other litter	OriginalResults_Total	OriginalResults_per_m2	OriginalResults_Comment	DataVerification_Paper	DataVerification_Cigarettes	DataVerification_Plastic
2	3_A010	1	A	0	0	1	1	0	0	2	4	0,57	Empty field means = 0	1	0	0
3	3_A010	1	B	0	1	0	0	0	0	0	1	0,14		0	1	0
4																
5																

	Q	R	S	T	U	V	W	X
1	DataVerification_Metal	DataVerification_Glas	DataVerification_Foodleftover	DataVerification_other litter	DataVerification_Total	DataVerification_Comment	DataVerification_AcceptReject	How can the difference be explained?
2	2	0	0	2	5		Reject - photo does not reflect data	
3	0	0	0	0	1		Accept - photo and data perfect match	
4							Accept – photo and data match approximately	Litter items on photo overlap; it seems like two items b
5								

	Y	Z	AA	AB	AC	AD	AE	AF	AG
1	Accepted_Paper	Accepted_Cigarettes	Accepted_Plastic	Accepted_Metal	Accepted_Glas	Accepted_Foodleftover	Accepted_other litter	Accepted_Total	Accepted_Comment
2	0	0	1	1	0	0	2	4	
3	0	1	0	0	0	0	0	1	
4	apart; ...								
5									

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Worksheet: Group B data verification

	A	B	C
1	DatasetID	Type of error made	Approximate number of items affected
2			
3			
4			
5			

Worksheet : Group D data verification

	A	B	C	D	E	F	G	H	I	J
1	DatasetID	Microplastic	Scientist	Photo	Colour	SizeMM	Type	FTIR_Plast	FTIR_Polymer	FTIR_MethodUsed
2		Unique ID for each particle found in the sample	Name of scientists analysing respective sample	File name of associated photo			hard fragment, soft fragment, film (flat and bendable particle), monofilament, pellet	Yes = FTIR analysis validated that this particle is plastic	Indicate which polymer was identified by analysis	Enter here which method was used, including the name of the device and databases as well as how often particle was analysed. Ideally write a short protocol and include a link to this document here.
3										
4										
5										