



marlin
BALTIC MARINE LITTER



BEACH LITTER MEASUREMENT METHOD DESCRIPTION

1 | Introduction

One of the biggest obstacles to being able to resolve the problem of marine litter is the lack of information that can be used to determine the sources of litter, the litter's patterns of movement in the sea, the dynamics of the oceans, trends and other more general information regarding the status of marine litter. This type of information is both necessary and fundamental in order to be able to assess the consequences of marine litter at a local, regional, national and global level.

Many efforts have been made globally to map the litter situation in marine environments, and the measurement of litter on beaches has historically been seen throughout the world as the most common method of assessing the strain placed on the marine environment as a result of litter. However, one problem has been that the results from most of the studies undertaken have not been directly comparable due to the different measurement methods that have been used.

The lack of a uniform standard led UNEP/IOC to develop harmonised guidelines during 2009 regarding the measurement and monitoring of marine litter. The aim is for these guidelines to be able to be used throughout the entire world. The hope is that the data and materials collected in accordance with these guidelines will be able to support the local and global measures being taken to combat marine litter. Another hope is that the work in itself, and the results of the work, will awaken the interest of the general public to the issue of marine litter, since one way to come to terms with the problem of marine litter is to change people's attitudes and behaviour.

During 2011, UNEP/IOC's guidelines¹ for the measurement of litter on beaches were adapted to Baltic Sea conditions by the MARLIN project in cooperation with Statistics Sweden (SCB). This method description is the result of that work.

Litter measurements conducted in accordance with this method will contribute to new knowledge about the problem and, in the long term, will also contribute to reduced levels of litter and cleaner beaches.

More specifically, the method is aimed at providing support to those who wish to:

- quantify and categorise litter on beaches and, in the long term, develop methods aimed at stopping marine litter.
- identify possible sources of marine litter.
- provide comparable data for global, national, regional and local assessments of litter along our coastlines.
- increase the general public's awareness of the problem of marine litter along our coastlines.
- increase levels of knowledge about how litter along our coastlines affects our marine ecosystem.

2 | Performing the measurement

2.1 Preparations

Any municipality/organisation intending to perform litter measurements should contact project MARLIN in your country first in order to go through the preparations and planning. See steps should be done for the litter measurements (diagram1)

Choice of beach

The following criteria should be met in order for a beach to be deemed suitable for a litter measurement:

- The beach should be at least 100 metres long, and if possible 1,000 metres long. The method does not apply to beaches at inland lakes, nor does it apply to rocky shores along the coastline. Municipalities and other parties who wish to perform measurements at inland lakes and/or on shorter beaches can still use the method, although

¹ For anyone who wishes to read more about marine litter in general and litter measurements in particular, the UNEP/IOC Guidelines on Survey and Monitoring of Marine Litter can be found at www.projectmarlin.eu

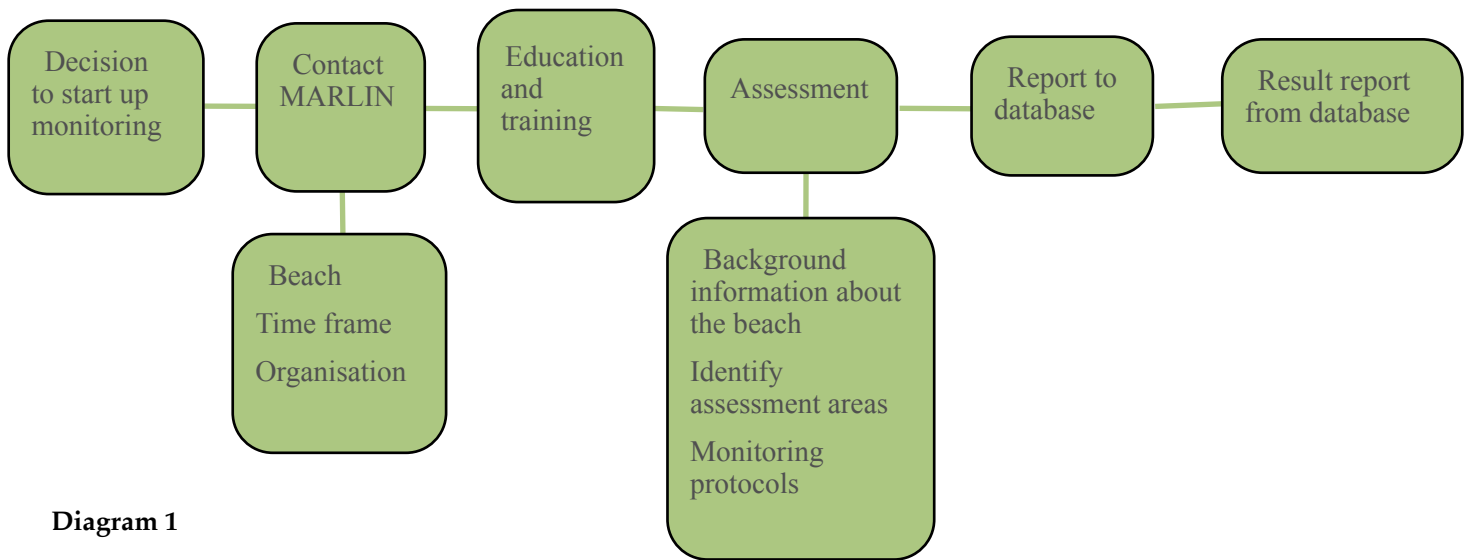


Diagram 1

the results of such measurements will not be able to be compared with other measurements performed in accordance with these guidelines. Please contact a project partner for further discussion.

- The beach may have a slope between 1° and 45°. This criterion is necessary to exclude very shallow areas that can be kilometres long at low tide.
- The beach should have free access to the sea, in other words it should not be blocked by, for example, breakwaters or jetties. If the beach lacks clear access to the sea, litter may be stopped that otherwise could be expected to float in from the sea.
- The beach should be available for measurement all year round.
- If possible, the beach should not be subject to other litter measurements or cleaning measures. If the beach is cleaned regularly, the times at which it is cleaned must be known.
- Litter measurements may not have any kind of negative impact on endangered species or other protected species, for example seabirds or sensitive shore vegetation.

The measurement period

Measurements should be performed on three occasions per year; once in the spring, once in the summer and once in the autumn. In this way the measurements capture seasonal variations during the part of the year when the beach is used the most.

- Spring (week number 13–20)
- Summer (week number 28–31)
- Autumn (week number 37–46)

It is important to consider that the results of a litter measurement are influenced by a number of factors, for example the time at which the measurement is performed and the weather conditions at that time. In order to achieve good comparability, the litter measurements should therefore be carried out on or around the same dates each year. However, consideration must also be given to the weather conditions at the time, and the litter measurement should be postponed until another day if it is particularly windy or if it is raining a lot on the planned day of the measurement. Furthermore, the litter measurement should never be performed directly after a beach has been cleaned, but should instead be carried out as close as possible prior to the cleaning of the beach. For practical reasons, measurements should be performed early in the morning so as not to disturb bathers and other users of the beach.

Appointing the team to perform the measurement

For every beach litter measurement, a project manager should be appointed from the local municipality or from the organisation that has ordered the measurement, and it is this project manager who has the chief responsibility for the measurement and for communications with the Marlin project group. Furthermore, a team leader should be appointed (the project manager and the team leader can be the same person, although they do not necessarily have to be the same person).

With regard to the actual execution of a beach litter measurement, it is recommended to appoint a work group consisting of at least four persons. The goal is to be able to carry out the litter measurement within approx. four hours. However, the work group should be aware of the fact that a litter measurement will normally take a longer time on the first occasion it is carried out.

The organisation that has ordered the litter measurement decides on the make-up of the work group for the measurement. A measurement can often be successfully carried out with the help of volunteers from interest groups, school pupils or the members of sports associations. It is, however, important to ensure that the participants are at least 15 years of age. Another viable alternative could be that the personnel responsible for the cleaning of the beach in question also perform the measurements just prior to their cleaning operations.

Training

The responsible partner provides training for the persons who will be carrying out the litter measurement on the first occasion the measurement is to be performed. The training is mainly of a practical nature, although it does also touch on the problems associated with marine litter.

At least one person who has been trained by the responsible partner must take part on each occasion a measurement is performed, and normally such a person would be suitable as the team leader. This person is in turn responsible for training any new participants taking part in a measurement for the first time, and for ensuring that the measurement is carried out in a correct manner.

Equipment

Below is a list of the equipment that should be used when performing litter measurements:

Materials supplied by MARLIN	Other necessary equipment	Other recommended equipment
Map/Orthophoto of the beach		GPS receiver of good quality
Protocol BC01 – Description of the beach (see appendix 1)		Digital camera Pens
Protocol BC02:1 – Background information and beach litter registration within Measurement Area 3 (see appendix 2)		“Pick-up sticks” for gathering litter Wet weather gear (as necessary)
Protocol BC02:2 – Beach litter registration within Measurement Area 1 (see appendix 3)		Scissors Knife
Protocol BC02:3 – Beach litter registration within Measurement Area 2 (see appendix 4)		Environmentally-friendly marker dye
Beach kit consisting of A3 clipboards, measuring tape, small flags for marking the measurement areas, a beach flag, 4 lengths of string (50 metres each) and 2 lengths of string (10 metres each)		Protective gloves Garbage bags Scales for weighing litter (if applicable)
		First aid kit

Food and drink

Mobile telephone

Sunhat/cap

Sunblock

2.2 Demarcation of measurement areas in the field

The chosen beach should be divided into three overlapping measurement areas (see diagram 2). It is important that the measurement areas provide a relevant representation of the beach in terms of position and geographical conditions as well as from a usage perspective.

Measurement Area 3 is the largest area and is made up of the entire beach (max. 1,000 m), Measurement Area 2 is 100 m and Measurement Area 1 is 10 m (see diagram 2). In order to be able to make comparisons of the levels of litter between different measurements and years, and to ensure that the final data is of requisite high quality, it is important that the same measurement areas are used on each measurement occasion. This is made possible through the use of GPS coordinates, photos and/or permanent reference points.

The first time a measurement is performed on the beach

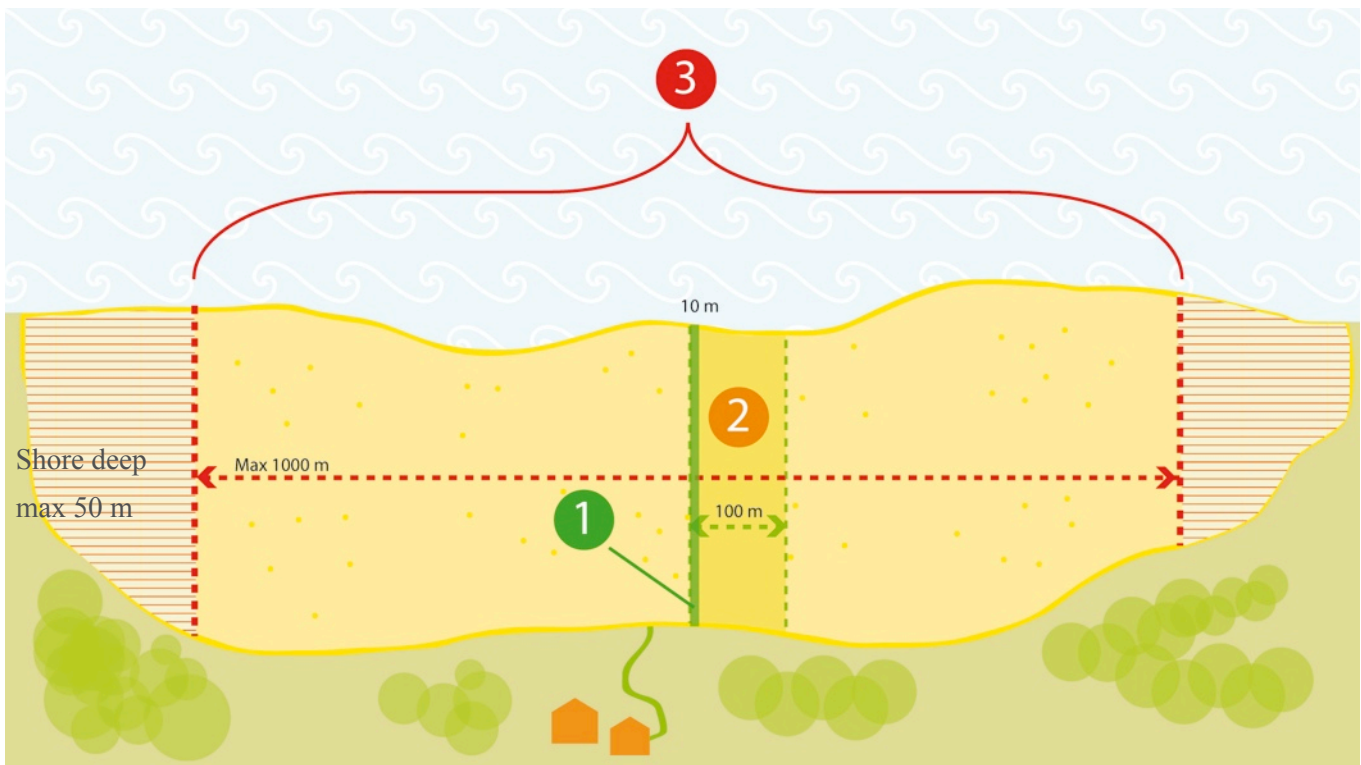


Diagram 2

2 The beach is deemed to end where, for example, the vegetation becomes more pronounced or where the beach starts to give way to rocks or sand dunes, or where a road or a physical obstacle begins (e.g. a wall, fence or building). If the beach is wider than 50 m, the width of the beach is demarcated at a distance of 50 m from the waterline, and this point is then deemed to represent the rear edge of the beach.

In brief, the method involves measuring up and demarcating three areas on the beach. When the areas have been measured up and demarcated, you perform area calculations and then count all the litter that exists within the areas. Below you will find a more detailed description of how to go about this process.

Before the areas are measured up on the beach, protocol BC01 and parts of protocol BC02:1 should be filled in (see appendix 1-2).

- Begin by determining the starting point for Measurement Area 1 (10m) and Measurement Area 2 (100m). Try to select an area that is free from obstacles (buildings, boulders etc.), ideally with a side that is formed by a permanent landmark. It is important that the area is representative of the beach as a whole. The starting point should be located midway between the water's edge and the rear edge of the beach¹. Set up a measuring tape between point A and B, and place a peg in the middle to mark the starting point (see diagram 3). You should also mark point A and B with pegs.
- Working from the starting point, you should now set up a 100 metre long length of string (or two 50 m measuring tapes) in the direction of the waterline to mark the length of Measurement Area 2 (see diagram 3).

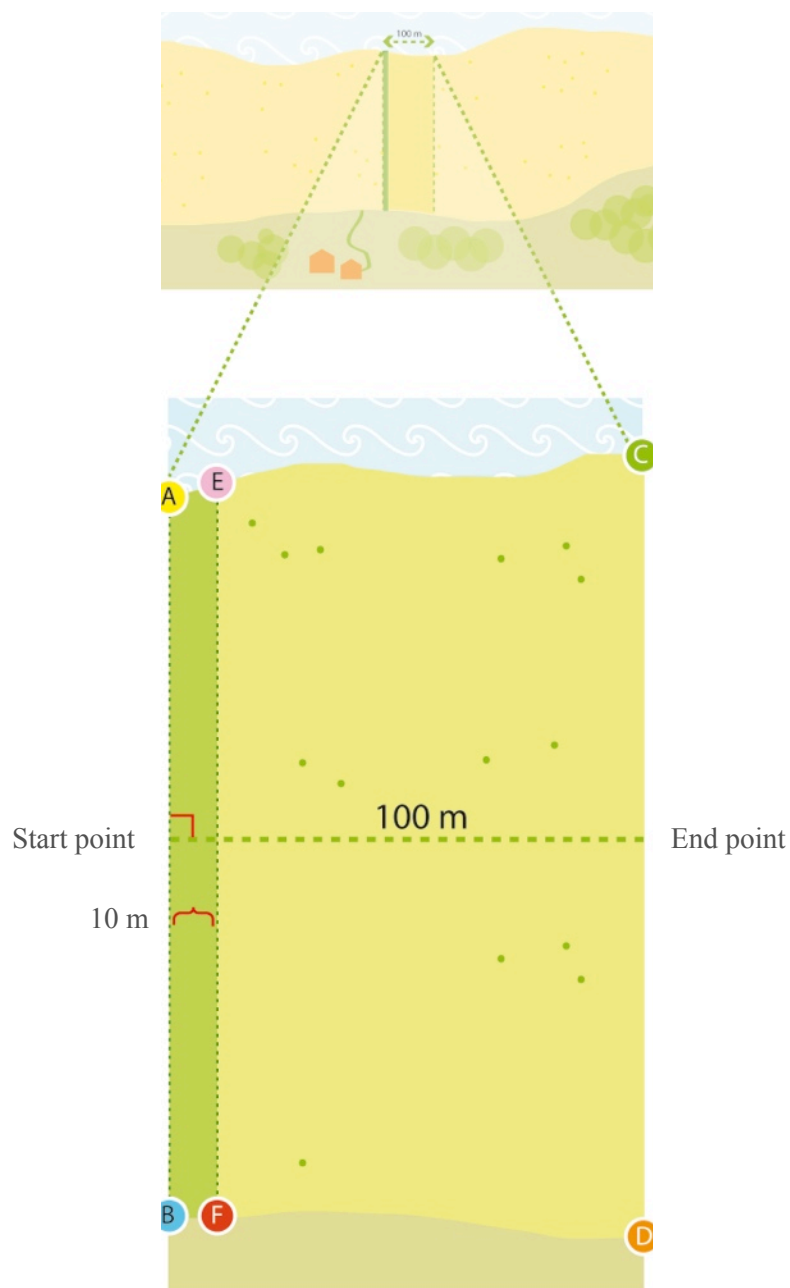


Diagram 3

Set up a measuring tape between point C and D, and place a peg in the middle to mark the finishing point. You should also mark point C and D with pegs.

The distance between the starting point and the finishing point should be 100 metres, and the angle between the starting point line and the finishing point line, in other words between A & B and C & D, should be 90 degrees.

- Set out pegs (E and F) to mark the waterline and the rear edge of the beach, ten metres from point A and B. You should then affix a length of string between these pegs. The angle between this length of string and the aforementioned 100 metre long length of string should be 90°. This area represents Measurement Area 1.
- Determine the coordinates of the four corners for Measurement Area 2 (A–D) as well as for the points E and F with the help of GPS, and note these coordinates in the protocol. You should also mark these points on the map and document them by way of photo to make it easier to find the same points when performing future measurements. Calculate the average width and the area for Measurement Area 1, and record this information in protocol BC02:1.

METHOD 1: Calculate the area of the measurement area (m²) by measuring the distance between A-B and E-F. Calculate the average by dividing by two, and then multiply the result by 10 m (see diagram 4).

METHOD 2: Calculate the area with the help of GPS (please consult with MARLIN beforehand).

- Calculate the area for Measurement Area 2 and record it in protocol BC02:1.

$$\text{Area of measuring surface} = \frac{(\text{blue circle} + \text{red circle})}{2} \times 10 \text{ m}$$

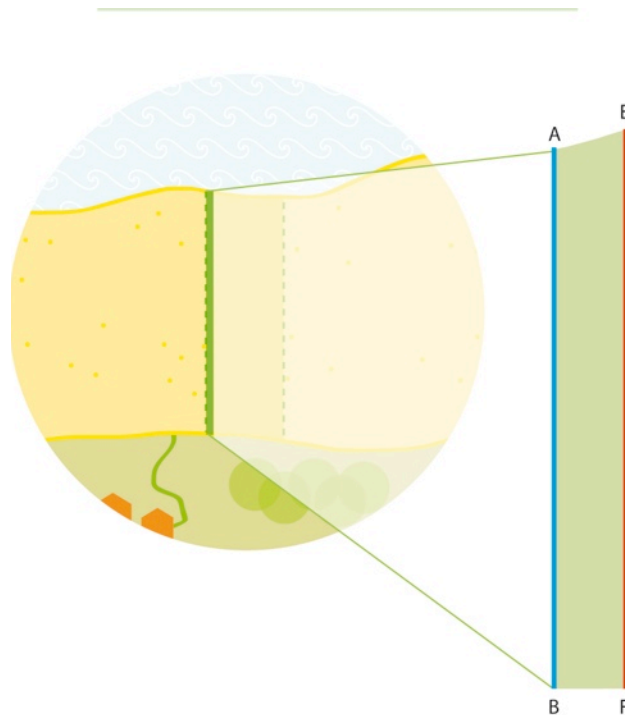


Diagram 4

METHOD 1: Calculate the area of the measurement area (m²) by measuring the width at five points (every twenty-five metres). Calculate the average by dividing by five, and then multiply the result by 100 m (see diagram 5).

METHOD 2: Calculate the area with the help of GPS (please consult with MARLIN beforehand).

- Measurement Area 3 (see diagram 5) represents the entire beach but should be no more than 1,000 metres long. Select a part of the beach that is representative of the entire beach, and measure up the length. Use the map or GPS to help you. Calculate the area and record it in protocol BC02:1. You should also make a note of the coordinates for the corners (G-I, see diagram 5) for Measurement Area 3 in the protocol and on the map.

METHOD 1: Calculate the area of the measurement area (m²) by measuring the width of the beach at a minimum of five different points. Calculate the average, and then multiply the result by the length of Measurement Area 3 (see diagram 6). Use the map or GPS to help determine the length of the beach.

METHOD 2: Calculate the area with the help of GPS (please consult with MARLIN beforehand).

Other (i.e. not the first) measurement occasions

Use the GPS coordinates, map, photographs and any permanent reference points on the beach to mark out the same measurement areas as have been used during previous measurements. Mark out the points A to F, and affix a length of string between point A and B, between C and D and between E and F.

Please be aware that the distance between the waterline and the rear edge of the beach along the 100 metre long stretch will normally vary throughout the year due to waves and tides. Consequently, the points at the waterline will not be at exactly the same location every time, which means that the areas need to be recalculated on each occasion.

$$\text{Area of measuring surface} = \frac{\text{Yellow} + \text{Blue} + \text{Green} + \text{Orange} + \text{Purple}}{5} \times 100 \text{ m}$$

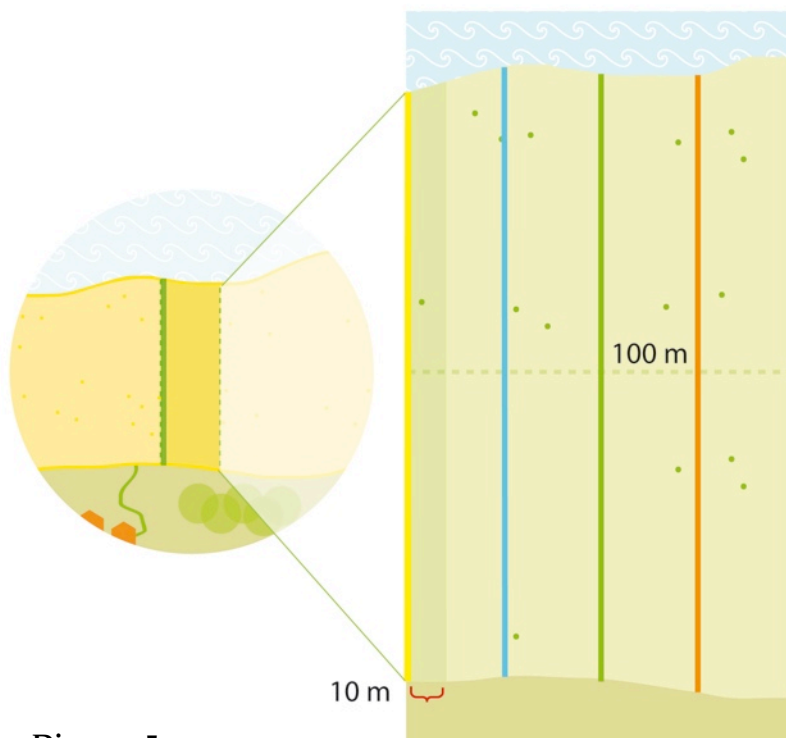


Diagram 5

$$\text{Area of measuring surface} = \frac{\text{Yellow} + \text{Blue} + \text{Green} + \text{Orange} + \text{Purple}}{5} \times \text{the entire beach (max 1000m)}$$

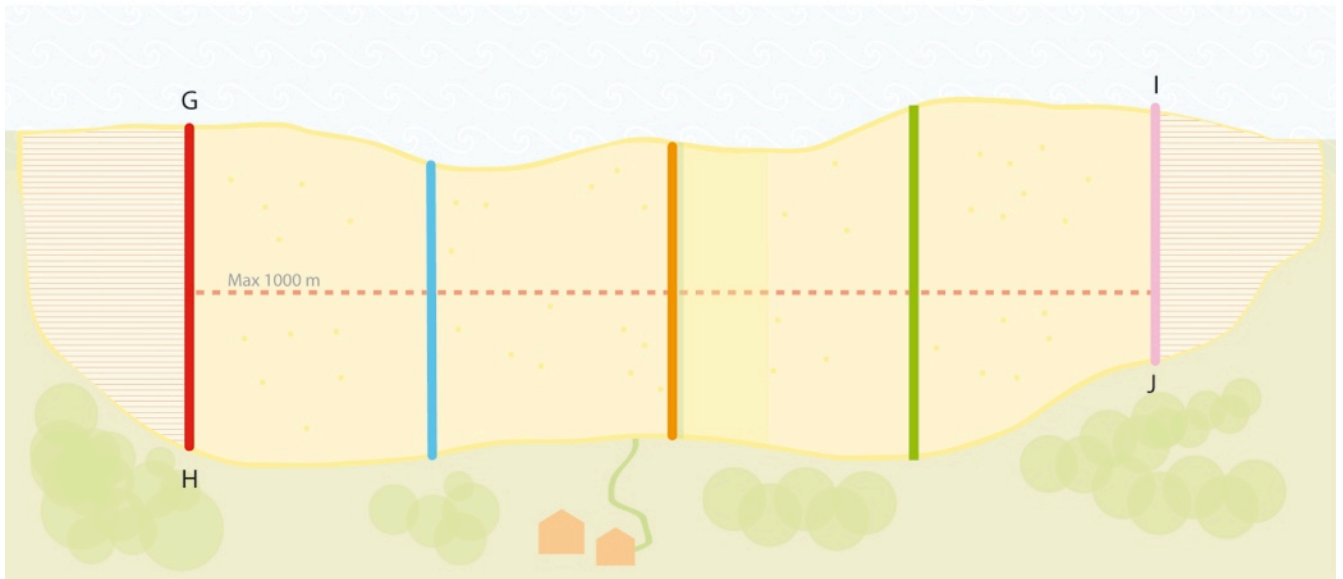


Diagram 6

2.3 Registration and classification of litter

Once the measurement areas have been defined, all items of litter that exist within each measurement area should be counted, gathered in, classified and categorised according to material type and litter type (see diagram 7).

Only visible litter should be counted. In other words, litter that is totally buried in the sand should NOT be counted, and the same applies to items of litter in rubbish bins. If it is obvious that several items of litter belong together (e.g. the pieces of a broken bottle), these should only be counted as one item, but in all other cases each item of litter should be counted separately.

Start by counting the litter within Measurement Area 1, thereafter Measurement Area 2, and finally Measurement Area 3.

Measurement Area 1: here cigarette butts and discarded snuff portions are included.

Measurement Area 2: here it is items of litter ranging in size (length) from 2.5 to 50 cm (not cigarette butts or discarded snuff/snus portions) that are to be counted. It is OK to make a visual estimation of the size of the items of litter. Objects that could be borderline size-wise (e.g. a bottle cap) should always be counted.

Measurement Area 3: here it is all items of litter that are bigger (longer) than 50 cm that are to be counted.

When a cigarette butt or snuff/snus portion is picked up, this should be noted in protocol BC02:2 (see appendix 3).

When items of litter ranging in size from 2.5 to 50 cm are picked up, this should be noted in protocol BC02:3 (see appendix 4).

Items of litter that are larger than 50 cm should be noted in protocol BC02:1 (see appendix 2).

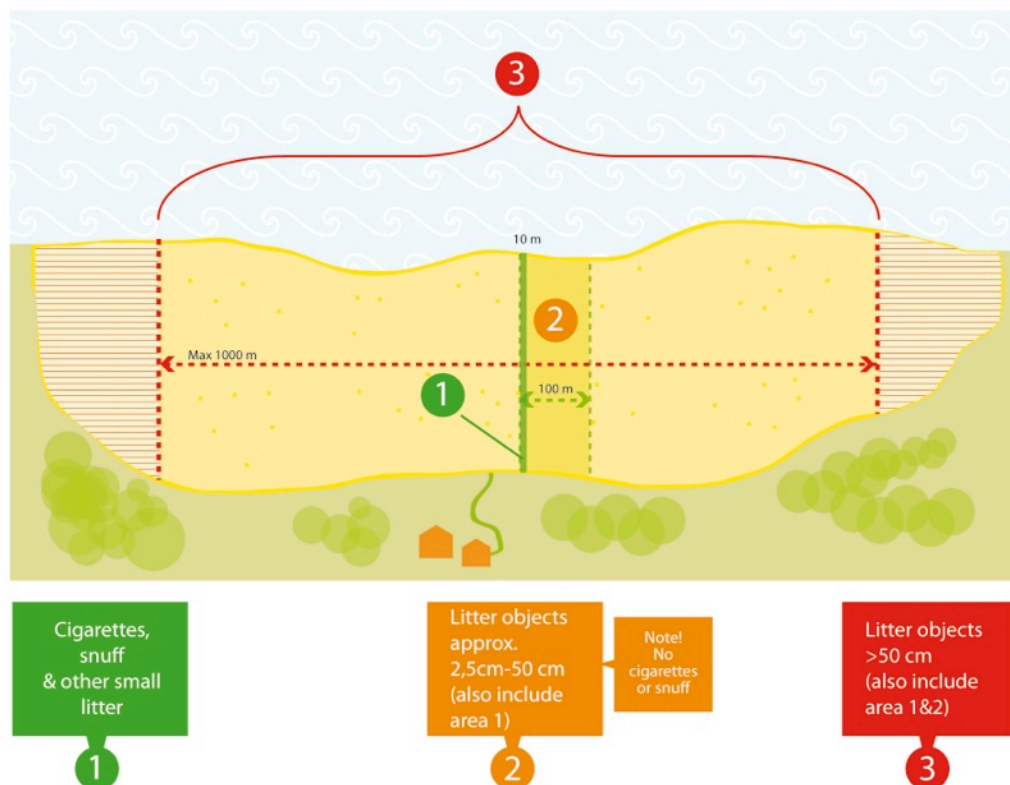


Diagram 7

Method for calculation of litter

For Measurement Area 1 & 2, the work group (at least four persons) count and pick up litter as they move between the rear edge of the beach and the shoreline (see diagram 8).

The work group is divided up into smaller groups of two persons each, whereby one person counts the items of litter and the other person makes notes in the relevant protocol(s). The person making the protocol entries should walk directly behind the person counting the litter to ensure that no litter is missed. If an item of litter is missed by the first person but is spotted by the person keeping the protocol, that item of litter should also be collected and registered in the protocol.

To begin with, group 1 sets out a length of string parallel to the length of string that runs between the rear edge of the beach and the waterline (i.e. between point A and B). The distance between these two lengths of string is decided on by the measuring team depending on the amount of litter in the area and previous experience. The recommended distance is between two and five metres. At the same time, group 2 sets out a length of string parallel to the length of string that the first pair has set out.

The persons in pair 1 then move between the rear edge of the beach and the waterline. They record in the relevant protocol the details of the items of litter they find within their area, and they also pick up those items of litter. Pair 2 does the same thing within its area.

When pair 1 is finished with its area, they set out a new length of string a further two to five metres away, and parallel to the length of string previously set out by pair 2. The litter within this new area shall now be picked up and recorded in the protocol by pair 1.

The work is then continued by each of the pairs in a similar fashion until all of Measurement Area 1 and 2 has been covered.

Measurement Area 3 is the same as the area that has previously been demarcated as representing the entire beach (max. 1,000 metres). It is recommended to use 1–4 persons to calculate the litter within this area. Here it is all items of litter that are larger than 50 cm that are to be counted and recorded in protocol BC02:1. A suggestion is that the persons involved walk in a line parallel to the shoreline with a space of a few metres between them (see diagram 9).

When it is possible for the persons in the work group to pick up and remove items of litter themselves, in a safe manner, they should do so. Items of litter that cannot be removed by the work group should be marked with e.g. environmentally-friendly marker dye. The reason for marking such items is to avoid counting them twice. The work group should then inform the responsible landowner about the location of these items so that they can be removed in a safe manner. In order to facilitate the removal of large items of litter, it could be a good idea to identify the location of such items with the help of a GPS receiver, or to mark the location on a map. Return the measurement areas to their original condition once all measurements have been completed, and make sure that you pick up all the pegs and lengths of string that have been set out during the process.

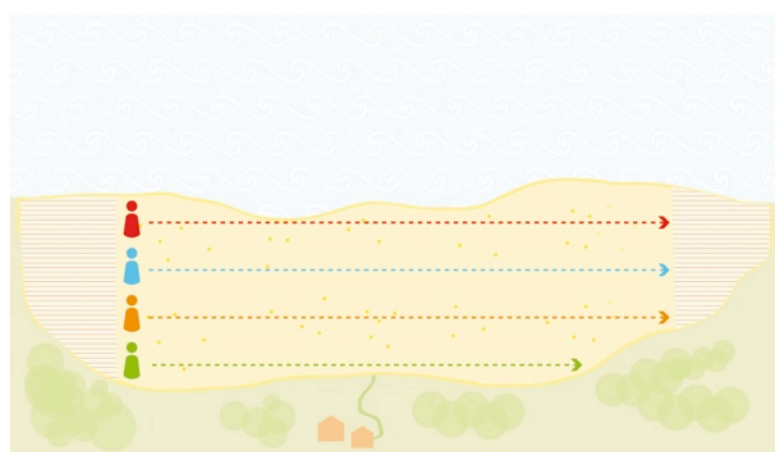
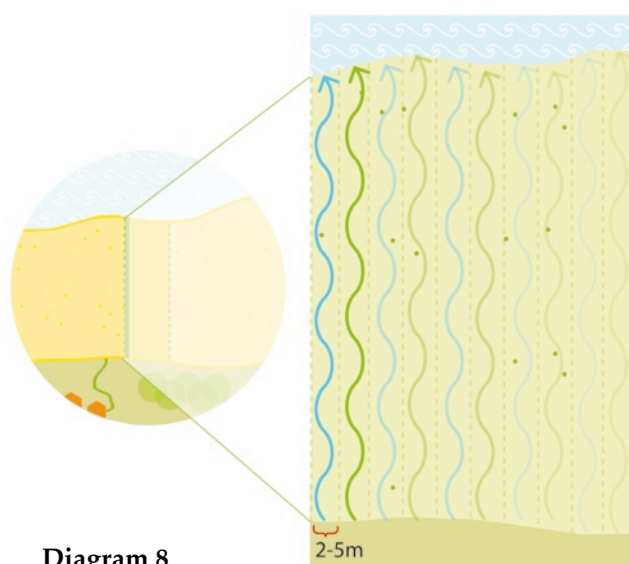
Make sure that all the litter that has been collected is removed from the beach and sorted for recycling once the measurement process is completed.

3 | Data registration

Data registration should be carried out as soon as possible after the measurement process is completed. The registration is done in the project web-based database at www.projectmarlin.eu. The login details are sent to the relevant municipality / party when the measurement is ordered. A member of the work group may be contacted if the responsible partner has any questions about the data that has been collected and registered.

Once the data registration is completed, the filled-in forms are to be sent to the responsible partner in the postage-paid envelope supplied.

Please see the separate manual for complete instructions regarding data registration.



4 | Results

The data is analysed by the responsible partner, and the results are reported as the amount of litter per area unit (since the last time the beach was cleaned) as well as the amount of litter per metre of beach (since the last time the beach was cleaned). The results are reported in the form of tables and diagrams. In most cases the litter types will be aggregated into material classes when the results are reported.

The results should be used to monitor the level of litter on a specific beach over time. In this way it is possible to evaluate the results of any measures taken to combat litter. Comparisons of the results from measurements carried out at different beaches should be made with caution, since there is a risk that the beaches will have been demarcated in somewhat different ways.

The background information about the beach and about the conditions at the time of the measurement increases the quality of the survey. Conclusions can be drawn with the help of such information when repeated surveys have been carried out at the same beach.

5 | Reference & quality control

Below is a description of how MARLINS method description is in keeping with UNEPS/IOC's guidelines.

5.1 Criteria for choice of beach

According to UNEP/IOC's method, the beach should have a low to moderate slope (15–45°). This is necessary to exclude very shallow, muddy areas that can be kilometres long at low tide.¹ Furthermore, according to UNEP/IOC's method, a beach should not be subject to regular planned cleaning measures.

5.2 Choice of measurement unit

According to the UNEP/IOC method, the amount of litter is only to be reported per metre of beach. This key figure can, however, be misleading, since different beaches are of differing width. Consequently, as a supplement to this key figure, we have also chosen to report the amount of litter per area unit.

5.3 Choice of unit of measure

In many countries, counting the number of items of litter (e.g. plastic forks and ice-cream sticks) is deemed to be the best way to provide a fair picture of the litter situation. However, problems can arise if the items of litter vary significantly in size (e.g. fishing net and cardboard boxes). For such items it would be more relevant to record the weight. The method of recording weight is, however, usually far more troublesome, since the items must be dry when they are weighed. Furthermore, people find it difficult to relate to weights. For example, few people can determine how many kilos of ice-cream wrappers it takes for a beach to be deemed to be littered.

UNEP/IOC does not favour one particular unit of measure above the others. Based on the above argument, in this method we have chosen the number of items of litter as the unit of measure. However, in protocol BC02:1 there is a field in which the weight of the items of litter can also be recorded as applicable.

5.4 Litter classification

The litter classification that is used in the MARLIN method is based on UNEP/IOC's guidelines. Marine litter is defined as all waste, discarded or lost material, which is found on the beach as a result of human activities. This definition does not encompass natural elements such as branches, seaweed etc.

The classification system consists of two levels: firstly one identifies which material the item primarily consists of, after which one identifies the shape of the item. The classification system in UNEP/IOC consists of nine different material classes, including an "other" class, and a total of 77 different types of litter.² In MARLIN model we have chosen to expand the classification system with the material class "organic waste", and we have also added a further four types of

¹P age 24 of UNEP/IOC Guidelines

²Page 17 of UNEP/IOC Guidelines

litter (snuff/snus portions, faeces (excrement), leftovers from fruit, food, pastries, sweets and ice-cream, and other organic litter). We have also added disposable barbecues under the material type “metal”.

5.5 Measurement periods

For the purposes of UNEP/IOC reporting, a litter measurement must be performed at least once per year and beach. However, if the party arranging the measurement so wishes, it is quite OK to carry out a litter measurement on one single occasion in order to gain a picture of the situation at that particular point in time. Above all else, the beaches should be measured when they are most in use, which in Sweden means that the measurements should be performed in July and August. UNEP/IOC recommends that the measurement be carried out every third month, in other words once during each season of the year. Considering the nature of the Baltic climate, however, we feel that three measurement occasions per year is sufficient (spring, summer and autumn), and it is this frequency of measurement that is proposed in this method description. In this way the seasonal variations are captured during the part of the year when the beach is used the most.

5.6 Registration of litter within measurement areas

UNEP/IOC proposes two different ways of structuring the work involving the counting of the litter, depending on the number of persons in the work group. In this method description, we have based our description on the method whereby the work group (at least four persons) counts litter while it moves between the rear edge of the beach and the waterline (see diagram 4).

5.7 Training

The key to achieving good quality results is having careful and well-informed personnel. When performing measurements on a recurring basis, it is an advantage if at least one or a few persons have taken part in an earlier measurement process at the location. We point out earlier in this method description that at least one person who has received training from one of the project partners should be present during a measurement process.

5.8 Protocols

Protocols BC01, BC02:1, BC02:2 and BC02:3 are in accordance with UNEP/IOC's proposed protocols for comprehensive beach litter assessment, but with some additions.

BC01 in this method is in accordance with BC01 in UNEP/IOC's protocols for comprehensive beach litter assessment. BC02:1 in this method includes the proposed protocol ML01 (large items). BC02:2 is the protocol for the registration of litter within Measurement Area 1 (cigarette butts and snuff/snus portions), and BC02:3 is the protocol for the registration of litter within Measurement Area 2.

The protocols have been simplified to some extent with a number of multiple-choice questions. Tide data is not registered in the Baltic Sea due to the fact that the impact of the tides is very small in the region. The protocols have also been supplemented with questions about the number of visitors, the number of rubbish bins within the measurement area, which sea the beach is adjacent to, any dead animals, camping and/or café/restaurant facilities that are adjacent to the beach, as well as information about cleaning measures taken.

Contact information for MARLIN

Keep Sweden Tidy: info@hsr.se +46 8 505 263 00

Keep the Estonian Sea Tidy: marlin@hem.ee +372 51 76 019

Keep the Archipelago Tidy: roope@pssry.fi +358 2 274 5500

FEE Latvia: fonds@zemesdraugi.lv +371 67225112

Marlin webpage: www.projectmarlin.eu