METHODOLOGY FOR IDENTIFICAION OF HOTSPOTS AND LITTER REDUCTION MEASURES

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INTRODUCTION

The present Methodology was developed in the framework of the contract 93-OP20-10(2)/01.10.2020 between Municipality of Burgas and P-United Ltd. for Lot 1 "Development of Methodology for identification of hotspots and litter reduction measures". The Methodology includes the recommended steps to follow in identification, assessment and ranking of hotspots located within the Black Sea catchment area and having impact on the state of the Black Sea. As a concept the methodology is applicable to any other sea.

In compliance with the regional LBSA Protocol (2009), hotspot means a limited and definable local land area, stretch of water surface or specific aquifer that is subject to excessive pollution and necessitates priority attention in order to prevent or reduce the actual or potential adverse impacts on human health, ecosystems or natural resources and amenities of economic importance.

For the purposes of this Methodology, the hotspot is considered to mean:

A) Point source on the coast of the Black Sea (or further in the Black Sea catchment area where appropriate), which potentially affect human health, ecosystems, biodiversity, and economy in a significant manner. They are the main points, where high levels of pollution loads originating from domestic or industrial sources are being discharged and where sustainable development is being threatened;

B) Certain areas where the environment is subject to pollution from one or more point or diffuse sources on the coast (or inland) that could potentially significantly affect human health, ecosystems, biodiversity, the economy and sustainable development generally.

Thus, in the HS Methodology hotspot is not only the point source itself, but also the environment, which is affected. The quality of the later (ecological and socio-economic status) is taken into consideration in hotspots identification and especially in prioritization.

In preparation of this methodology, the draft hotspots Methodology – Guiding harmonization in identification and prioritization of hotspots in the Black Sea Region (project "Integrated hotspots management and saving the living Black Sea ecosystem") was taken as a basis, as well as best available practices in the development of national (under various projects)

and regional (Arctic Seas, MEDPOL, DABLAS, HELCOM, OSPAR) methods of identification, evaluation and ranking of point sources of pollution.

The Methodology allows to identify and rank hotspots located on the territory of the Black Sea catchment area.

The Methodology is developed by the following experts:

	Expert	Position
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6	Assoc. Prof. PhD Petar Petrov	Non-Key Expert - Environmental Planning
7	Master of Ecology Elena Georgieva	Non-key Expert - Biodiversity - Birds
8	Master of Ecology Iva Fikova	Non-key Expert - Fauna
9	Master of Ecology Gabriela Neykova	Non-key Expert - Biodiversity - Flora and vegetation
10	Eng. Veneta Stefanova	Non-key Expert - Coordinator

I. DEVELOPMENT OF METHODOLOGY FOR IDENTIFICAION OF HOTSPOTS

1. ANALYSIS OF EXISTING LITERATURE SOURCES

Surveys of litter stranded on the coastline are a primary tool for monitoring the load of litter in the marine environment and have been used world-wide to quantify and describe marine litter pollution. They can be used to measure the effectiveness of management or mitigation measures, identify the sources and activities leading to litter pollution and determine threats to marine biota and ecosystems (Cheshire et al., 2009).

For the purposes of developed Methodology in the framework of this Lot, the definition of marine litter includes any manufactured or solid waste entering the marine environment irrespective of the source (see Coe and Rogers 1997). These are most often objects and materials that are made or used by man and intentionally or not thrown into the sea, rivers or beaches, brought by storms or wind. They may also be accidentally lost, for example as a result of bad weather.

Major land-based sources of marine litter include tourism, recreation, illegal dumping, waste disposal sites, input from rivers, sewage and storm water outflows. The part of solid waste generated and received in the marine environment reaches 20%, as major sea-based sources are commercial shipping, fisheries activities, pleasure crafts and off-shore installations.

Regarding the so-called offshore sources (maritime transport, fishing) - the share of solid waste generated and received in the marine environment reaches 20%, with special attention to obsolete, lost or abandoned fishing tackle and in particular fishing nets, which are significant a risk factor for the conservation of marine mammals. Regarding the composition of solid waste in the marine environment and along the coast, the data show that over 80% is the share of waste composed of or containing plastics or other polymer-resistant materials.

Coastal cleanup actions are therefore an effective method to reducing the litter into the marine environment. Monitoring studies have shown that coastal litter frequently gets resuspended, moved about the beach and washed back out to sea (Johnson, 1989; Garrity and Levings, 1993; Johnson and Eiler, 1999). Such movement of litter on a beach can greatly exceed

the cumulative input of litter (Bowman et al., 1998), and there is a marked negative relationship between sampling frequency and estimated litter accumulation rates (Eriksson et al., 2013; Ryan et al., 2014).

The main limitation in taking action to clean up the coastline and beaches is the identification and reporting of observations at pollution points where litter disposal action needs to be taken.

Coastal litter accumulation is highly variable, and may vary by up to several orders of magnitude both at regional and local scales (e.g., Lee and Sanders, 2015; Galgani et al., 2015; Pasternak et al., 2017). Variability in coastal litter accumulation is subject to location relative to litter sources and ocean transport (Critchell and Labmrechts, 2016), but also to characteristics of the coastline itself, such as gradient, curvature and substrate (Hardesty et al., 2017), the surrounding population density and proximity to land-based litter sources, etc. (Galgani et al., 2015). The most polluted beaches are not necessarily the most readily accessible ones (Hardesty et al., 2017).

It has been observed that the more difficult a beach is to access, the less inclined its visitors are to take their litter with them. The more accessible beaches, on the other hand, have a larger number of visitors, which is also a prerequisite for generating a large amount of litter. During the summer months, tourism is of major importance for pollution (A. Simeonova et al. 2017: 115).

In spring and autumn, currents and meteorological conditions can be named as the main factors for pollution. Moreover, with the presence of a river mouth near the beach, a larger amount of litter should be expected. It is therefore necessary to develop methodologies for monitoring solid waste pollution along coastal areas and identifying hotspots, developing models for forecasting the potential for litter accumulation and identifying high-risk areas through the accumulation of marine litter (Haar, 2019, Kataoka, 2015).

Around the world there are many marine litter monitoring programs and methods for identifying hotspots with different spatial and temporal scales, different scales for litter size, and different classifications of litter in coastal areas. The type of survey chosen depends on the objectives of the assessment and the area of coastline pollution.

Large-scale multi-annual monitoring campaigns by experts in the field are being implemented to assess the scale of the marine litter problem and to assess regional or temporary trends on the basis of statistical models. Another approach is to conduct monthly surveys, involving trained volunteers, at randomly selected locations along the coastline and beaches to identify the main sources of marine litter (Sheavly, 2007). The assessment of the cumulative accumulation and monitoring of changes in the accumulation of marine litter along the coastline and beaches by taking multiple snapshots at the point is also useful.

Most programs use different region-specific methodologies and criteria to identify spots that are heavily affected by marine litter. Qualitative criteria are environmental sensitivity and conservation importance, which are used to target environmentally important pollution spots. The density of litter accumulation is most often used as a quantitative criterion. Some programs report the number (or weight) of litter per unit length of shoreline (Bowman et al., 1998, Barnes and Milner, 2005) or the beach (e.g., Velander and Mocogoni, 1999), while others report the number (or weight) of litter per unit area of the coastline (e.g. Acha et al., 2003).

Among the latest tools for identifying hotspots is the development of numerical models that, based on the circulation of marine currents and the location of marine litter sources, track their movement and identify the beaches most likely to be affected.

The identification covers the following stages:

Raw data collection (Monitoring)

In order to identify the hotspots of marine litter pollution, it is first necessary to collect data on the characteristics of the litter, including an analysis of its composition, spatial distribution and, where possible, litter sources, the hydrographic characteristics of the area.

The monitoring methods applied along the coastline and beaches must provide reliable and, if possible, easily understandable information on all these factors. According to Guidance on

Monitoring of Marine Litter in European Seas, it is necessary to monitor a point several times. One-off monitoring does not allow it to be identified as a hotspot.

At least four surveys per year in spring, summer, autumn and winter are recommended. However, because of the large seasonal variation in amounts of litter washed ashore, initially a higher frequency of surveys may be necessary in order to identify significant seasonal patterns, which can then be considered when treating raw data for long-term trend analyses.

The survey periods below are suggested:

1) Winter: Mid-December–mid-January

2) Spring: April

3) Summer: Mid-June–mid-July

4) Autumn: Mid-September–mid-October

Preferably, the surveys for all participating beaches in a given region should be carried out within the shortest timeframe possible within a survey period. Furthermore a given beach should be surveyed on roughly the same day each year if possible.

When identifying hotspots, it is important to monitor points away from known sources of pollution in order to better reflect the reference values for background levels of litter pollution or near potential sources, using temporary trends for assessments.

Undertaking the identification of hotspots the need to:

(i) consider data over the longest possible period so as to help understand changes in the data including natural variability as well as anthropogenic influences;

(ii) use the latest available data from monitoring programs;

(iii) update all data used in the assessment at least once every six years;

(iv) use data from the same time period when combining datasets as much as possible;

(v) compare the latest six-year assessment period with the previous six-year assessment period in order to report progress in achieving the targets.

Identification of hotspots

The main criterion for developing scales for the identification of hotspots with marine litter may be the number, weight or volume or a combination of these units per unit area. The number

of items is recommended as a standard unit by which to assess the litter load along the coastline. Estimation of litter is problematic as it depends on whether the litter is wet or dry and often whether it is covered or filled with sand and gravel (Jambeck & Farfour 2011). Some items are even too large to be weighed and their weight must be estimated. Estimating the volume of litter is also problematic, as it depends on the level of compression of the litter. Determining the volume of litter, especially in the field, is difficult and gives only a rough idea of the amount of litter.

A widely used method for comparing the cleanliness of beaches is the "Clean Coast Index" (CCI), and according to the different levels of pollution, beaches are divided into five categories. CCI is based on the density of the Artificial polymer materials found in determined beach transects on the exact territories and allow marine litter loading assessment of the beaches/ coastline. However, in Bulgaria, with the data generated by the institutional monitoring of beach marine litter, this index cannot give a sufficiently clear idea of the total marine litter loading. This is due to the fact that with comparison to other sea basins and coasts, in which Artificial polymeric materials make up to 80-90% of the all accumulated marine litters, and in some cases even exceed 90%, in Bulgaria this percentage is significantly smaller (final report prepared under contract 93-OP19-1/5/07.05.2019 between Municipality of Burgas and the "Nikola Vaptsarov" Naval Academy within Lot 2).

2. SELECTION OF TEAM - EXPERTS WITH APPROPRIATE QUALIFICATION AND SPECIALTY (WATER, MARINE LITTER, POLYMERS, CHEMICAL ENGINEERS, ORNITHOLOGISTS, ENVIRONMENTALISTS) TO USE THE METHODOLOGY FOR IDENTIFICATION HOTSPOTS

To identify hotspots it is necessary to form an appropriate team consisting of a leader and experts to ensure reliable and quality collection of field data.

The minimum requirement for the team is to consist of a manager and 1 expert, and at least one of them needs to have skills to work with GPS and spatial image processing software.

It is recommended that the team include other experts - two of whom - field experts, to participate in field data collection and one expert database and modeling, in case the modeling of marine litter distribution will be performed.

One or two teams of at least two experts are needed to apply the methodology in the field within one trial area. The large number of experts is necessitated by the need to study a large number of sample areas within the optimal period of time to conduct the collection of the necessary information to identify hotspots.

Surveys for all beaches involved in a given region should be carried out as soon as possible during the optimal survey period.

The experts must have undergone preliminary training to assimilate the methodology and its application in the field.

List of experts, their duties and selection criteria are presented in **Table 1.**

Table 1. *Obligations and criteria for selection of members of the team for identification of hotspots*

Expert	Obligations	Selection criteria
1	2	3
Team leader	Manages hotspot identification activities. Participates in the collection of field information on the classification of marine litter by categories and subcategories, waste	Qualification in the field of environmental protection and waste.

Expert	Obligations	Selection criteria
1	2	3
	sources and the categorization of hotspots.	
Expert Geodesy	Participates in the process of geodetic survey of marine litter so that its quantities and location can be determined.	Qualification in the field of geodesy.
Expert Water	Participates in determining the sources of marine litter - discharge points, rivers / streams and other water bodies. Participates in determining the potential for pollution of the coast due to sea currents.	Qualification in the field of environmental protection, hydrology, hydrogeology, oceanology.
Expert Biodiversity	Participates in assessing the impact of marine litter on coastal and marine biodiversity.	Qualification in the field of ecology and environmental protection.
Expert GIS and database	Participates in the modeling of sea currents and the distribution of litter in time and space, so as to identify potential hotspots.	Qualification in the field of GIS and databases.

An important condition is that the field work is always performed by a minimum of two experts for the safety of the team.

It should be borne in mind that certain circumstances can lead to dangerous and risky situations for team members: e.g. strong wind, slippery rocks, storms, etc.

As hotspot identification is associated with field work, the safety of team members is paramount. For this reason, each of them should be familiar with some basic safety rules, some of which are listed below:

- Team members should have appropriate clothing and footwear, protective gloves, hats, raincoats and more (depending on the season).
- Each team member must carry an emergency communication device, for example a mobile phone.
- All teams should be equipped with a first aid kit, which should include sunscreen, insect repellent, etc.
- Each member of the team must carry enough water with them.

- Large, heavy debris should remain in place and team members should not attempt to lift it, as their weight may have increased further as a result of wetting and lifting may cause injury.
- In case of suspicious litter, team members must report to the relevant competent authority.
- Team leaders may supplement other rules, depending on the specific situation and the specifics of the object of study.

3. SUMMARY DESCRIPTION OF POTENTIAL SOURCES OF POLLUTION

3.1 Sources of marine litter pollution along the coast

Sources of marine litter are divided into two groups: land-based (onshore) and sea-based (offshore). The two groups suggest different approaches to dealing with them.

Land-based (onshore) sources

Land-based sources include improperly located or illegal landfills, uncovered waste containers, garbage machines, poorly managed waste from production processes, processing and / or transportation of goods, etc. Wastewater treatment plants as well as storm sewers can also be sources of litter at sea if they are unable to retain solid waste. Coastal activities, as well as visitors to the beaches, also often contribute to the loading of the coast and the sea with various types of litter. This type of litter is overwhelmingly single-use in nature, namely drinks bottles, bottle caps, food packaging, plastic cups, drinks stirrers, etc. Wind is clearly a factor in this material becoming litter, but many of these items are also deliberately or carelessly left on the beach. Materials used in the home, such as consumer cosmetics, as well as polyester and acrylic fibers, when washing fall into the sewer, and from there - into the sea.

The share of land-based sources reaches up to 80% of the total amount of solid waste generated and received in the marine environment.

Sea-based (offshore) sources

Sources of marine litter can also be various activities that people perform at sea. Many items and materials fall directly into the marine environment from merchant, military and research vessels, passenger ships and pleasure yachts, offshore platforms and their supply vessels. Some of the litter falls into the water in case of accidental loss, others - as a result of gaps in the waste management systems or their illegal dumping. Fishing - professional and amateur - is a source of nets, ropes, buoys and floats, as well as other accessories. They can be intentionally dumped, abandoned or lost during a storm. The growth of fish, molluscs, crustaceans and other aquatic organisms such as aquaculture also contributes to the increase of such materials in the marine environment.

The share of solid waste generated in the marine environment reaches 20%.

Some of the sources of marine litter (land-based and offshore) are presented in **Figure 1.**

Figure 1. *Sources of marine litter (terrestrial and offshore)*

(Source: https://cleancoasts.org/marine-litter/)

3.2 The main sources of pollution along the Black Sea coast

The main sources of pollution, including solid waste, in marine waters along the Black Sea coast are the following:

1. Stationary land-based discharges, which include discharges of industrial waste water and insufficiently treated or untreated wastewater from coastal settlements and other urban areas;

2. River runoff, including - water flowing directly and indirectly into the Black Sea through the rivers - waters from sites of agriculture, industry, extraction and treatment of wastewater from the entire catchment area of the Black Sea;

3. Coastal diffuse sources with water from agriculture, including livestock and unorganized tourism, mainly through runoff from land-based sources (coastal waters and groundwater);

4. Offshore platforms and other offshore equipment, through the disposal of solid waste, explosives and dredges; disposal of polluted water and ballast water; oil spills; lost fishing nets; the introduction of foreign marine organisms, including the overgrowth of marine facilities and structures;

5. Atmospheric precipitation through the introduction of various sources of air pollution (smoke, fumes, exhaust gases, dust and other solid particles), regardless of where they occurred, in view of the transboundary action of air currents.

Of these main sources, the first four groups are of greater importance for the generation of solid waste in the marine environment, and among them are the following specific sources that should be monitored:

- Urbanization - municipal facilities for waste and sewerage networks (household litter);
- Sea transport and ports (ship litter);
- Tourism and recreational activities in the coastal zone (litter generated by the local population and the tourist flow);
- River runoff, including - direct or indirect litter entering through rivers;
- Commercial and recreational fishing (including abandoned nets);
- Construction activities in the coastal zone (including housing construction);
- Agriculture;
- Transboundary transfer of floating solid waste between water basins, etc.

4. DESCRIPTION OF THE MAIN CATEGORIES OF MARINE LITTER AND THEIR OCCURANCE ON BEACHES (ANALYSIS OF DATA PROVIDED BY THE CONTRACTING AUTHORITY), PRESENTED AS AN ANNEX

The main categories of marine litter, subject to the Institutional marine litter monitoring (regarding criteria D10C1), which is carried out in connection with the implementation of the requirements of the EU Marine Strategy Framework Directive (MSFD 2008/56/EC) are:

- Artificial polymer materials: e.g. cigarette butts and filters; Plastic/polystyrene pieces 2.5 cm > < 50cm; plastic caps/lids unidentified; cups and cup lids; crisps packets/sweets wrappers; Plastic/polystyrene pieces 0 - 2.5 cm; drink bottles >0.5l; Plastic caps/lids drinks, etc.;
- Rubber: e.g. balloons; tires; rubber boots; rubber bands, etc.;
- Cloth / Textile: e.g. clothing/rags; shoes and sandals (e.g. leather, cSPh); carpets; ropes; sails, canvas etc.;
- Paper / Cardboard – e.g. paper bags; cardboard boxes; cartons/tetrapack milk; cigarette packets; newspapers and magazines, etc.;
- Processed / worked wood – e.g. corks; pallets; toothpicks; ice-cream sticks; paint brushes, etc.;
- Metal – e.g. aerosol/spray cans; cans (beverage); cans (food); aluminium foil; bottle caps; tableware (plates, cups & cutlery); car parts; appliances (refrigerators, washers, etc.); paint tins; gas bottles, etc.;
- Glass/ceramics – e.g. bottles; jars; light bulbs; fluorescent light tubes; tableware (plates & cups), etc.;
- Unidentified – e.g. medicinal items; paraffin/wax, etc.

Each category consists of different number of subcategories - a total of 217. Largest is the number of subcategories in Artificial polymer materials category - 124, while in the rest of the categories the number is considerably lower - from 7 to 26 subcategories.

An analysis of the data provided by the Municipality of Burgas on the occurrence of the main categories of marine litter on the beaches is presented in **Annex 1.**

5. DERIVATION OF CRITERIA FOR IDENTIFYING HOTSPOTS: QUANTITY / TYPE OF LITTER

5.1 The necessary data for marine litter loading evaluation

To assess the load of marine waste in the target area, it is necessary to make an analysis of waste deposits on the following main indicators:

- Qualitative composition of the disposed litter by categories and subcategories of the litter;
- Quantity of the accumulated marine litter;
- Classification of the predominant litter;
- Area of accumulation of litter;
- Period for accumulation of the registered quantities;
- Marine litter sources;
- Main marine litter waterways of “movement”.

5.2 Marine litter loading evaluation scales

For marine litter loading evaluation is used a scale developed in implementation of contract P-04-1/21.01.2020 between Via Pontica Foundation and "Nikola Vaptsarov" Naval Academy within SP 1 "Identification of hotspots of marine litter pollution in the target area". Experts from the Naval Academy have developed five-rated scale, based on the purpose, the requirements for the evaluation scale’s scope and the principles in the structuring of evaluation scales, as well as on similar evaluation tools worldwide. This scale allows a clearly differentiation between the marine litter loading rates to be done, as well as it facilitates the researched areas condition assessment.

The main criterion against which the marine litter loading evaluation scale is structured is the density of marine litter (unit / m^2) and Marine Litter Density Index (MLDI) is proposed to be adopted (Toneva & Simeonova) using the following formula:

$$MLDI = Dav * K,$$

Where:

Dav – average density of marine litters from the main categories "Artificial polymer materials", "Paper/Cardboard", "Processed/Worked wood" and "Metal" for one monitoring campaign for the determined area of interest, [unit / m^2].

K – coefficient, with perceived value 20 (for statistically needs)

According to the data from the institutional monitoring of beach litter (2015-2018), the four main categories of materials with the highest relative share in relation to the total amount of litter are: "Artificial polymer materials", "Paper/Cardboard", "Processed/Worked wood" and "Metal". That is why only they are taken into account when forming the scale for reporting the load of marine litter. In case the density of the litter from the categories: Cloth/textile, Rubber, Glass / ceramics and Unidentified exceeds 1 unit / m^2, then its value should be taken into account when calculating the average density of the litter.

We propose the following algorithm and the calculation procedure proposed from the "Nikola Vaptsarov" Naval Academy is as follows:

- Determine / calculate the average amount of marine litter accounted from the 4 groups of material ("Artificial polymer materials", "Paper/Cardboard", "Processed/Worked wood" and "Metal") for one monitoring campaign from the annual monitoring for the area of interest. It shall be calculated as simple average value,[unit.]
- Determine / calculate the total average amount of marine litter accounted from the 4 main groups [unit] within the area of interest. (it shall be calculated as a sum of the already attributed average values of the marine litters by 4 groups of materials,[unit]);
- Determine / calculate the average density of marine litters from the main groups "Artificial polymer materials", "Paper/Cardboard", "Processed/Worked wood" and "Metal" for one monitoring campaign for the determined area of interest, [unit / m^2] (total average amount marine litters referred to the determined area).
- Determination / calculation of MLDI.

The scale developed from "Nikola Vaptsarov" Naval Academy covers the range of D*av* (average sum density of marine litters from the 4 main groups"Artificial polymer materials", "Paper/Cardboard", "Processed/Worked wood" and "Metal" for one monitoring campaign for the determined area) and MLDI (Marine Litter Density Index), presented in **Table 2**:

Table 2. *Marine litter loading evaluation scale (Toneva & Simeonova)*

Dav [unit / m²]	***MLDI***	**Evaluation**
1	2	3
Dav = 0÷0,1	***MLDI*** = 0÷2	**Unloaded area**/ very clean area
Dav = 0,1÷0,25	***MLDI*** = 2÷5	**Low loaded area/** clean area
Dav = 0,25÷0,5	***MLDI*** = 5÷10	**Moderate loaded area/** moderate littered area
Dav = 0,5÷ 1	***MLDI*** = 10÷20	**Heavily loaded area/** very littered area
Dav ≥1	***MLDI*** = 20 +	**Critically loaded area/** extremely littered area

Each areas with ***Dav*** ≥ 1 и ***MLDI*** = 20 + are considered to be critically loaded areas / extremely littered areas. They are hotspots.

5.3 Hotspots categorization scale

Within the scope of this contract a scale for the categorization of hotspots has been developed. The scale is also five-point, based on the purpose, the requirements for the scale and the principles in the structuring of rating scales, as well as the internationally applied scales with similar purpose. This makes it possible to clearly distinguish the different categories of hotspots and helps to assess the condition of the study areas. At the same time it allows the use of adequate to the specifics of the target area interval values of each of the ranks.

The scale for categorization of hotspots is presented in **Table 3**.

Table 3. *Hotspots categorization Scale*

Dav [unit / m²]	***MLDI***	**Category**
1	2	3
Dav = 1 ÷ 2	*MLDI* = 20 ÷ 40	hotspot – first rank
Dav = 2 ÷ 3	*MLDI* = 40 ÷ 60	hotspot – second rank
Dav = 3 ÷ 4	*MLDI* = 60 ÷ 80	hotspot – third rank
Dav = 4 ÷ 5	*MLDI* = 80 ÷ 100	hotspot – fourth rank
Dav ≥ 5	*MLDI* = 100+	hotspot – fifth rank

The scale developed under this contract categorizes hotspots into 5 categories. Each category is determined by rank, depending on the pollution with marine litter. Depending on the extent of the relevant hotspot, the time period in which waste management action must be taken is determined as follows:

- First rank hotspot - a hotspot at which action must be taken within more than 24 months;
- Second rank hotspot - a hotspot where action must be taken within 12 to 24 months;
- Third rank hotspot - a hotspot where action must be taken within 6 to 12 months;
- Fourth rank hotspot - a hotspot where action must be taken within 3 to 6 months;
- Fifth rank hotspot - a hotspot at which action must be taken immediately.

6. PREPARATION OF AN ANNEX TO THE METHODOLOGY, WHICH IS A FIELD IDENTIFYING OF HOTSPOTS

For identification of hotspots, has been developed a Field Form (**Annex 2**) in three parts:

- Collection of data required for identification of hotspots;
- Categorization of identified hotspots;
- Results.

Part I Collection of data required for identification of hotspots

Part I Collection of data required for identification of hotspots must to be completed in the field and used to identify hotspots in Part II. It shall contain:

General information

- Name of the beach / shore – the official name has to be filled in;
- Country – the country in which the study area is located has to be filled in;
- Season – the season of information collection has to be filled in;
- Sequence of monitoring – the order of the monitoring for the respective season is indicated, as well as whether it was done within the same or a previous monitoring campaign (e.g. 2nd monitoring / previous campaign means that data from a survey conducted in the same season but for a previous year are available; 2nd monitoring / current campaign means that one survey has already been conducted in the same season and the same year);
- Date of survey – the date on which the information was collected must be filled in.

Determination of the study area

For identification of a hotspots, it is necessary to be determined a representative study area - a 100-meter section of a 1000-meter section of the sea beach / shore. To facilitate the experts, a sketch is provided to indicate the required information.

Geographical data for the study area

After determing the representative study area its geographical data are filled in the table Geographical data for the study area. The table requires information on:

- Total length of beach / shore – the total length of the beach measured in the middle of the beach has to be filled in;
- GPS coordinates start 100-meter section;
- GPS coordinates end 100-meter section;
- GPS coordinates start 1000-meter section;
- GPS coordinates end 1000-meter section.

Information about the beach / shore, object of research

It is required to fill in information with the help of which to characterize the studied area:

- Area of the beach / shore – the area must be measured in m^2;
- Beach / shore topography – the slope must be measured in %.

The subsequent information about the studied beach / shore has to be filled in as between several possible choices that characterize the respective indicator, the correct one is marked with X or ✓. If in the proposed elections there is no suitable for the respective beach, then in the field "Other", the expert can fill information at his discretion.

- Shape of beach / shore – the form of the studied beach / shore is chosen between three possible choices: Protrude, Rectilinear and Bay. In case the shape of the beach is different, the expert fills it in the field "Other".
- Back of beach / shore – the back of beach / shore is chosen between three possible choices: Rock cliff, Anthropogenic object (s), Dunes. In case the studied beach / shore borders on another type of object, the expert fills it in the field "Other".
- Type of beach material – the type of beach material is chosen between three possible choices: Fine sea sand, Rocks with spaces of sand / small stones, Small stones and gravel. In case the predominant faction on the studied beach / shore is different, the expert fills it in the field "Other".
- Major beach / shore usage – the type of beach use is chosen between five possible choices: Tourism and recreation; Fishing; Swimming; Water sports; Camping. If the purpose of

the beach is different, the expert records it in the field "Other". It is possible to choose more than one destination, due to the expectations for different use of the beach in different seasons.

- Access to the beach / shore – the way in which the beach can be reached is chosen between three possible choices: Vehicles; Boat; Pedestrian. In case the beach is accessible in another way, the expert fills it in the field "Other". It is possible to choose more than one way to access the beach.
- Predominant wind direction – the predominant wind direction is chosen between 9 possible choices: N, NE, E, SE, S, SW, W, NW. More than one choice is possible.
- Predominant direction of sea currents – the predominant direction of sea currents is chosen between 9 possible choices: N, NE, E, SE, S, SW, W, NW. More than one choice is possible.
- Notes: Additional information is filled in at the discretion of the expert.

Environmental factors that may influence the results of the study

The presence of adverse factors during the collection of information that may affect the results of the study has to be marked with X or ✓. The expert can choose between the following possible options: Wind, Rain, Snow / Ice, Fog, Sand storm, No influencing factors. If there is another factor that may affect the study, the expert fills it in the column "Other". More than one answer is possible.

Potential sources of waste that may affect the results of the study

It is required to fill in information only for the possible sources, which the expert considers to have a significant impact on the pollution of the studied beach / shore.

- The nearest settlement - the information about the name of the nearest settlement, which would be related to the pollution of the studied beach / shore has to be filles, as well as its type, distance (km) from the studied area to it. To be filled if applicable.
- The nearest commercial sites - the information on the availability of commercial sites - restaurants, shops, cafes that would be relevant to the pollution of the studied beach / shore has to be filled in, as well as the distance from the study area to them, km. To be filled if applicable.

- The nearest port - the presence of a port that would be related to the pollution of the studied beach / shore has to be filled in, as well as the distance to it, km. To be filled if applicable.
- The nearest river - the name of the nearest river / stream, etc. that would be relevant to the pollution of the studied beach / shore has to be filled, as well as the distance to them (km). To be filled if applicable.
- Availability of river mouth – the availability at the mouth of a river / stream, etc. has to be marked with X or ✓.
- Discharge points (pipes or sewer outlets) - the availability of pipes and sewers that have direct contact with the beach / shore and flow into the sea has to be marked with X or ✓;
- Notes - additional information has to be filled at the discretion of the expert.

Beach / shore cleaning

- Is the beach / shore being cleaned - the correct statement has to be marked with X or ✓: yes or no.

If the answer is yes, the following information has to be filled in:

- Period of beach / shore cleaning – the Beach / Shore Cleaning Period should be marked with X or ✓: Year-round or Seasonal;
- Frequency of beach / shore cleaning - the beach / shore cleaning frequency has to be marked with X or ✓: Daily, Weekly, Monthly. If the cleaning frequency is different, the expert fills it in the "Other" column;
- Beach / shore cleaning method - beach / shore cleaning method has to be marked with X or ✓: Manual, Mechanical;
- Date of last cleaning - the date of the last cleaning of the beach has to be filled, if known.

Data for the organization / expert responsible for collecting and filling in the data in the Field form

Data on the organization / expert responsible for data collection in the Field form has to be filled in

- Organization - the name of the organization responsible for collecting data in the Field flan has to be filled in;
- Expert - the name of the expert responsible for collecting data in the Field form has to be filled in;
- Contacts - the phone number and email of the expert responsible for collecting data in the Field form has to be filled in;

Scheme of the beach / shore, object of study

The beach / shore scheme is performed at the discretion of the expert performing the survey of the respective beach / shore. The purpose of the scheme is to illustrate the shape of the beach / shore, its area and size, the located anthropogenic sites (restaurants, hotels, shops, etc.), rivers / streams flowing into the sea, etc., points of discharge, available ports, etc. Exemplary scale for drawing the scheme: 1 square = 10 m.

A sample version is attached to the scheme to help the experts illustrate the situation on the beach.

Information on the quantities of litter by categories

It is required to fill in the quantities of litter by categories and subcategories, counted on the survey area. For this purpose, each of the categories with their respective subcategories is presented in a separate table. The name of the litter category is written in the first row of the table. For each category are presented the subcategories of litter with their - TSG_ML General Code, OSPAR Code, UNEP code and name.

A column number of litter (field counting) is provided to facilitate the counting of litter in the field. In it, each counted litter is marked with |, and when their number reaches 5 or 10 they are crossed out: 𝍸), then the total number of litter from this subcategory is written with a

number in the column "Total". At the end of each table there is a row "Total", which indicates the total number of litter from all subcategories to each category.

In case of difficulties in determining the specific category / subcategory of litter, it is recommended to use the Photo Guide, presented as **Annex 3** to this Methodology for identification of hotspots.

Have the reported wastes been collected

The correct statement has to be marked with X or ✓: Yes or No

Notes

An additional information has to be filled, at the discretion of the expert - e.g. presence of dead / distressed animals, accidental events (e.g. shipwreck) that may affect the results of the study, etc.

Part II Categorization of identified hotspots

Based on the data collected in Part I of the field form, the identified hotspots are categorized. This part does not have to be completed in the field, but it is recommended that it be completed as soon as possible after data collection

In Part II, the necessary data for calculating the Marine Litter Density Index - MLDI are filled in and the category of marine litter load is determined.

$\boldsymbol{MLDI}=\boldsymbol{Dav}*\boldsymbol{K}$, K = 20

To make it easier to calculate $\boldsymbol{MLDI}$, the table below has to be filled in:

$\boldsymbol{DAPMav}$	$\boldsymbol{DP/Cav}$	$\boldsymbol{DPWav}$	$\boldsymbol{DMav}$	$\boldsymbol{Dav}$	$\boldsymbol{MLDI}$
unit / m^2					**-**

To calculate the density of the individual waste categories Artificial polymer materials ($\boldsymbol{DAPMav}$), Paper / Cardboard ($\boldsymbol{DP}$ / $\boldsymbol{Cav}$), Processed/worked wood ($\boldsymbol{DPWav}$), Metal ($\boldsymbol{DMav}$) it is necessary to divide the total number of reported litters by the area of the beach / coast.

To calculate the average density of litter, it is necessary to collect the values for the average density of litter from the categories: Artificial polymeric materials (***DAPMav***), Paper / Cardboard (***DP / Cav***), Processed/worked wood (***DPWav***), Metal (***DMav***) .

$$\boldsymbol{Dav} = (\boldsymbol{DAPMav} + \boldsymbol{DP} / \boldsymbol{Cav} + \boldsymbol{DPWav} + \boldsymbol{DMav}).$$

In case the density of the litter from the categories: Clothes / Textile, Rubber, Glass / ceramics and Unidentified exceeds 1 unit / m^2, then its value should be taken into account when calculating the average density of the litter.

The scale (Toneva and Simeonova, 2019) in the Field form should be used to estimate the marine litter loading after MLDI calculation.

Marine litter loading

After the assessment of the marine litter loading, the established load category (Unloaded area, Low loaded area, Moderate loaded area, Heavily loaded area, Critically loaded area) has to be marked with X or ✓.

In case it is a critically loaded area (hotspot), its degree is determined according to the presented scale.

Hotspot category

The corresponding rank has to be marked With X or ✓ according to the scale: First rank, Second rank, Third rank, Fourth rank, Fifth rank.

Part III Results

In Part III must be done analys of the results obtained and indicates the factors that may be responsible for the results obtained, as well as the predominant category of litter.

Marine litter loading category

The established loading category (Unloaded area, Low loaded area, Moderate loaded area, Heavily loaded area, Critically loaded area) has to be marked with X or ✓.

Hotspot category

The corresponding rank has to be marked With X or ✓ according to the scale: First rank, Second rank, Third rank, Fourth rank, Fifth rank.

Factors that may be responsible for the results

The factors that may have influenced the results obtained have to be marked with X or ✓: Nearby settlement; Nearby commercial sites; Nearby port; Nearby or flowing river; Available discharge points, Sea currents. More than one answer is possible. At the discretion of the expert, another factor may be added in the "Other" field.

Predominant Category of litter on the studied beach / shore

The predominant category of litter must be marked with X or ✓: Artificial polymer materials; Rubber; Clothsh / Textile; Paper / cardboard; Processed / worked wood; Metal; Glass and ceramics; Unidentified.

Notes

An additional information must be filled, at the discretion of the expert.

II. DEVELOPMENT OF LITTER REDUCTION MEASURES

1. APPROACHES TO THE DEFINITION OF MARINE LITTER REDUCTION MEASURES

The problem with marine litter can only be fully addressed through an integrated waste management strategy that reduces or eliminates products at an early stage when they have the potential to become marine litter.

The basis of these strategies is already laid down in the EU Waste Framework Directive, which sets out the principles of the waste management hierarchy for prevention / reduction, reuse, recycling and recovery, which, if implemented more effectively over time, will provide the basis for a circular economy in which much waste becomes a valuable resource, leaving landfill as an option for only a small fraction of what is currently waste.

Although an integrated strategy will be needed to fully address the problem of marine litter, there is a set of measures that can be taken which are directly relevant to tackling it. The choice of measures and the degree of their relative importance depends on the determination of the type of litter, the impact they have, as well as their sources. Priorities depend on whether action is needed on the types and quantities of litter or on the significance of the impacts of specific types of litter on human health or the marine ecosystem.

Prioritisation by type of marine litter

Prioritisation can be given to those types of litter that appear most often or pose a significant threat to people and the environment. Beach surveys provide a database on the types of litter that allows us to identify problem items and so, to identify appropriate measures to address them.

The results of the analysis of the data from the Institutional monitoring of beach litter and the data collected within the RedMarLitter project show a significant dominance of litter from the category "Artificial polymer materials". This is in line with the trends observed around the world, according to which plastic litter on the shores is more than 80% of all others (according to the European Commission). This is closely related to the widespread production and use of plastic objects in all spheres of public and economic life of people, including in Bulgaria. Plastics make

up between 65 and 90% of the coastal litter found during the litter counting on the Bulgarian Black Sea coast. Almost half of all marine litter along the coast are disposable plastic products (final report on the implementation of contract 93-OP19-1/5/07.05.2019, between the Municipality of Burgas and "Nikola Vaptsarov" Naval Academy within Lot 2).

While wide-ranging and integrated measures are desirable, targeting particular types of litter can focus efforts on its reduction.

Prioritisation by impacts

Highest priority must be given to items of marine litter which present a risk to human health. Fishing nets and other gear present a direct threat to swimmers, divers, and surfers. Of single-use items, personal hygiene and medical products present an evident health threat to water sports enthusiasts, but also to anybody walking along or playing on beaches. Likewise, broken glass, shorn cans or sharp metal objects are an obvious risk. The impact of microplastics on human and environmental health is unknown, but the prevalence of such items is potentially considerable, noting also that all plastics will experience attrition over time into ever smaller pieces. Toxic substances could well be absorbed by human beings directly or through the consumption of fish products.

A comparably high priority must also be given to marine litter that has an environmental impact. Single-use items such as plastic bottle caps and plastic bags present an evident environmental risk to the marine environment and wildlife. The buoyancy of items such as plastic bottles means that they can be carried a long way by tides and currents. Smaller pieces of plastic or small shiny metal items can be ingested by marine mammals and birds with a direct environmental impact.

High priority should also be given to items that present direct economic costs, for example the impact of floating fishing gear on vessels or of ghost fishing on commercial stocks of fish and crustaceans. More difficult to address are the economic losses that could also follow more indirectly from the impact on ecosystem services, including marine environmental productivity and the marine food chain, including through fear of contaminants that could affect human health.

Prioritisation by source or pathway

Sources of marine litter can be land-based (onshore) and sea-based (offshore). Some of them are:

- Inadequate landfill management
- Inadequate storm water or wastewater impoundment, filtering or treatment.
- Discarded and lost gear from fishing vessels
- Discarded or lost materials and litter from freight shipping and cruise ships.
- Coastal tourism and amenity, etc.

Pathways include wind, rivers, tides and coastal activity, fishing and marine transportation, as well as deliberate dumping at sea or from land.

An understanding of the types of litter, the impacts of this litter and the sources of litter is important to identifying the measures to deal with the problem.

2. MARINE LITTER REDUCTION MEASURES

The measures that can be taken to reduce litter are conditionally divided into two groups:

2.1 Information measures to raise awareness

2.1.1 Conduct awareness-raising campaigns in coastal areas

Raising awareness of tourists on marine litter is therefore a way to prevent littering and its impacts. Informing the tourists on the damages caused by littering can influence positively their behavior to an eco-friendlier attitude. Informing them on the waste facilities and the legal framework when relevant (e.g., fines for littering) can influence them to better manage their litter. Thus, these two types of information should be provided through communication campaigns on marine litter.

Raising awareness communication campaign can be combined with specific actions to support the campaign and increase its effects, such as educational workshops for children and teenagers, artistic reuse initiatives, etc.

This measure could also be combined with other waste and litter management measures, such as:

- the improvement of the quality of infrastructure for waste disposal in coastal areas and beaches
- the provision of pocket ashtrays or small boxes for waste disposal
- clean-up events (including the monitoring of the collected litter to improve the knowledge of the local context)
- legal instruments to dissuade and avoid littering (implementation of fines, ban of certain products such as plastic bags, single-use cutlery, etc.)

The effect of the implementation of the measure could be enhanced by the establishment of an information center in the form of an obsolete caravan (or other appropriate) on the beaches visited by many tourists. It can be painted on the outside in an attractive way to attract the attention of more people. Campaigns around this information center will have a greater effect on raising awareness.

The combination of measures focusing on behaviour through education and awareness raising with measures focusing on waste prevention, measures focusing on litter and waste management and measures focusing on cleaning-up may increase the impacts of these measures by informing the tourists and giving them the opportunity to act and change their behaviour at the same time.

This type of campaigns can be very effective in promoting responsible behavior. Human behavior is often correctly described as something that is difficult to change, but this does not apply to all cases. Sometimes awareness can only stimulate small changes in behavior that lead to significant results.

Promoting better consumer behavior and recycling programs will prevent waste generation.

2.1.2 Increasing the capacity of the Black Sea municipalities

The Black Sea municipalities have a leading role in waste management in coastal areas and in the marine environment, respectively and in dealing with the problems associated with them.

Increasing their capacity in terms of integrated waste management, including assisting municipalities in introducing and improving separate waste collection systems, as well as in implementing control mechanisms, is key to reducing waste in general, in including, in particular, marine litter.

The implementation of this measure can be done through the organization of educational and training courses, seminars and other forms of training. In this way, the employees in the Black Sea municipalities will be able to deal more easily with the problems in waste management, as well as will have the opportunity to exchange experience with other municipalities and to borrow from them successfully implemented good practices.

2.1.3 Work with children and young people

Children and young people are a key target group to involve in activities that aim to sensitise the public about the issue of marine litter, not only because they are the next generation of decision makers but also because they have the capacity to inform and influence others in their

immediate environment. Educational structures, both formal and informal, have a very important role in educating children and young people, as do civil society organisations.

Research shows that young people are aware of various environmental problems such as pollution, hazardous and non-hazardous litter (including marine), but have difficulty understanding the causes of environmental problems and their solutions. It has been proven that children worry about these problems and treat them in an environmentally responsible way. It is important for young people to feel that they have the power to make a positive difference in the environment.

Whilst children can perform responsible environmental behaviours themselves directly, they also have the potential to bring about change by influencing peers, family and the wider community. Indeed research suggests that children shape the values of their parents and exert strong peer group influence. Whilst children may not have direct control over purchasing and disposal behaviours, indirect influence via parents and other adults may be highly effective. Moreover, research on environmental education and intergenerational learning indicates that children can influence the environmental knowledge, attitudes and behaviours of adults in various domains.

Working with children and young people is a key measure to reduce marine litter, although its results are visible in the distant future. The implementation of this measure can be done in many ways: e.g. introduction of educational programs in kindergartens and schools; conducting extracurricular activities in this direction; organizing competitions, quizzes, excursions, experiments, practical classes and any other similar events aimed at drawing the attention of children and young people to the importance of the problem with marine litter.

2.1.4 Development of a mobile application

This measure includes developing of a mobile application that combines citizen engagement with modern technology to help solve the problem of marine litter. Such an application will offer tools for collecting and sharing comparable data on marine litter on beaches. It will also provide a platform for participants registered in it to share their knowledge and develop approaches to marine litter monitoring. In order to make the application more efficient, it can provide an opportunity to organise various events, e.g. beach monitoring, beach cleaning, etc. In

order to achieve the applicability of the results, it would be appropriate for the application to use the list of types of marine litter in relation to the Marine Strategy Framework Directive, which is applicable throughout Europe.

2.2 Direct measures

2.2.1 Beach cleaning

Regular beach cleaning is a very effective means of dealing with litter and significantly reduces its spread, although it is aimed only at beach litter, but not at those reaching the sea from other sources. In addition, clean beaches encourage more responsible behavior, which also contributes to litter reduction.

Conducting litter collection events on the beaches ensures direct public participation as well as the collection of useful data. Ideally, waste collection should be complemented by an integrated approach that also aims to reduce (and eliminate) fishing litter, given the high presence of it on beaches.

Although the long-term effects of beach cleaning on the reduction of marine litter may be limited, their potential for raising awareness is great and should not be underestimated.

However, the collection of litter from the beaches still directly affects only the final result, without affecting the previous stages of the process.

It certainly cannot be done along the entire coastline and inevitably some of the litter that will reach the sea, remain in the water or sink to the bottom.

In addition, small or microparticles or fishing nets that are buried in the sand and dunes cannot be expected to be collected when cleaning beaches. It is also difficult to recycle much of the material collected due to corrosion or degradation, as well as litter contamination, e.g. with sand and others.

2.2.2 Installation of appropriate litter collection facilities along the beach - e.g. bins, etc.

The provision of appropriate litter bins and additional infrastructure such as signs and markings are direct measures that are a means of dealing directly with the problem of marine litter.

The effect of this measure could be enhanced, for example, by making litter bins more attractive to attract the attention of visitors to the beach. An example of such bins is shown in **Figure 2.**

Figure 2. *Litter bins located on the beach (Source: https://media.floridarealtors.org/realtors-bobby-and-nikki-freeman-a-can-do-attitude/)*

Writing facts about marine litter on bins could also enhance the effect of implementing this measure. These could be, for example:

- the time required for the decomposition of certain types of marine litter;
- facts about the amount of resources that could be saved as a result of separate waste collection and subsequent recycling;
- impact of litter on marine organisms, etc.

2.2.3 Creating an aeration screen

The measure include placing an aeration tube on the bottom of the waterway. By pumping air in this tube it creates an screen of air bubbles that pushes the floating plastic to the surface. By placing the aeration tube diagonally in the waterway, the plastic is also driven to the side of the waterway where it can easily be removed. For this reason, the concentration of microplastics in point 2 is significantly higher than that in point 3 (**Figure 3**).

In this way, some of the microplastics that are usually discharged into rivers and then end up in the sea can be removed, as they cannot be caught in treatment plants due to the lack of specific filters to remove such small plastic particles. A schematic diagram of such a facility is presented in **Figure 3.**

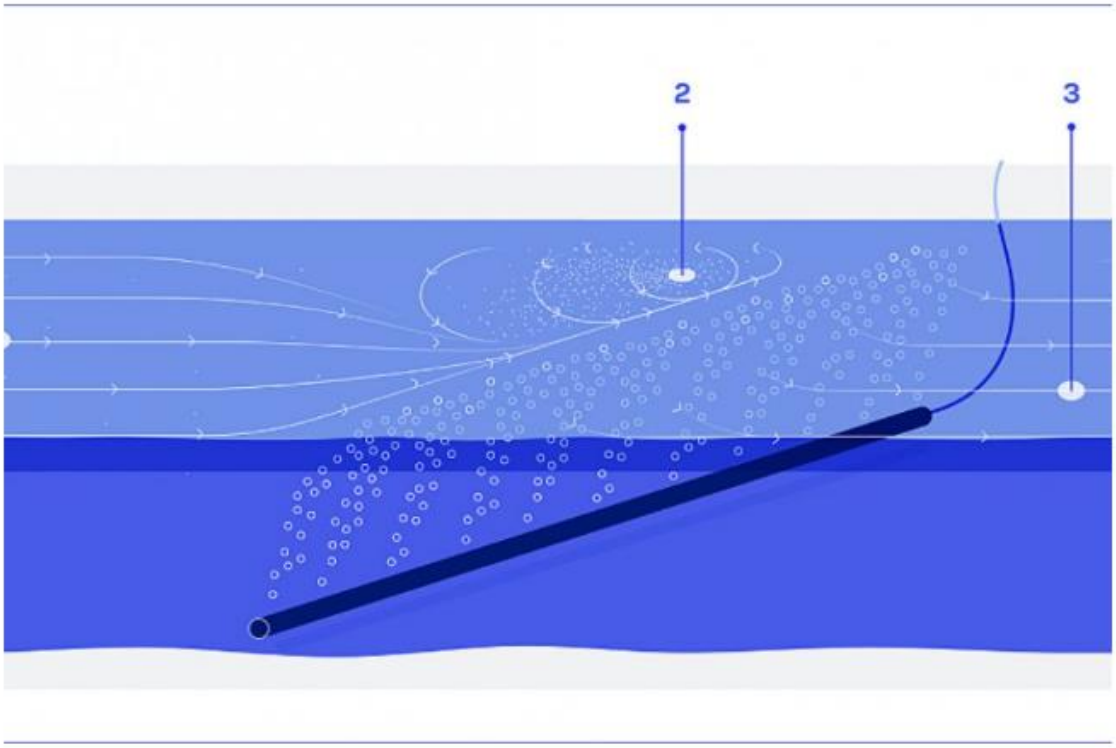

Figure 3. *Schematic diagram of creating an aeration screen*

(Source: https://www.dutchwatersector.com/news/bubble-barrier-catches-micro-plastics-from-effluent-sewage-treatment)

2.2.4 Placement of equipment / nets ("traps") in estuaries and canals to capture litter before it enters the sea

The measure consists of placing floating traps (collectors) for litter, which operate on the principle of a bypass valve and use the flow and pressure of water to capture and retain litter floating on the surface.

Litter nets are placed in the opposite direction of the water flow. Plastic litter is carried by the current and wind to the opening of the "trap", without requiring energy from human labor. Once the litter enters, it cannot be returned, even if the current changes direction. In this way, the nets provide an opportunity to collect plastic litter without obstructing the paths of aquatic animals. They are open so as to create easy escape routes for fish and other animals, birds can also fly through the open parts of the facility (**Figure 4**)

Figure 4. *Litter collection facility in rivers*

(Source: https://www.clearrivers.eu/litter-traps)

Another type of such facilities may be pipes that are attached so as to connect the two banks of the river and act as a barrier to floating litter (mostly plastic) (**Figure 5**). Once collected, the plastic can be sorted and sent for further recycling.

Figure 5. *Pipe connecting the two banks of a river, blocking floating litter (Source: https://www.thelitterboomproject.com/about)*

2.2.5 Installation of networks at the outlets of the drainage pipes from the city sewers, which are discharged directly

The purpose of these nets is to capture litter before discharge and to prevent marine pollution. Sewer pipes usually drain water from residential areas, along with the litterin it, which can seriously harm the environment. Especially during heavy rains, a large part of the litter is washed away and falls into the sewerage systems, and in the places where there are no Wastewater treatment plants - they fall directly into the sea. Placing such nets at the outlets of the pipes (**Figure 6**) will retain a significant part of this litter, which can then be separated and handed over for further recycling.

Figure 6. *Installation of sewer pipes*

(Source: https://brightside.me/)

2.2.6 Installation of facilities for direct capture of litter in the sea

They can be operated manually or automatically. Most such facilities perform other functions along with litter collection - e.g. removal of accumulated biomass on the water surface, collection of data on water quality, depth, etc. Some of the facilities collect the litter in themselves, and others - in nets attached to them (which may be old fishing nets). This type of equipment is generally very efficient and can collect a large amount of litter per day using a minimum amount of human hand or fully automatically. A schematic diagram of such a facility is presented in **Figure 7.**

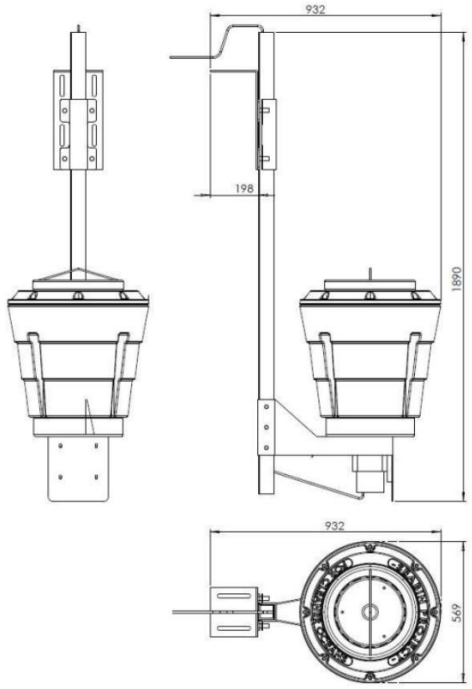

Figure 7. *Schematic diagram of a facility for direct capture of litter in the sea (Source: https://seabinproject.com/the-seabin-v5/technical-specs/)*

2.2.7 Use of special vessels for litter collection

This type of equipment is also suitable for capturing plastic litter from large rivers before it reaches the sea. The water flow is directed by a barrier to the opening of the vessel. Passing through it, the litter from the surface is transferred to a conveyor belt and through it is directed to special containers.

2.2.8 Involvement of fishermen in the collection of marine litter

Fishermen are among the key stakeholders that can have a significant impact on the marine litter problem. This can be done by providing large bags in which fishermen can collect plastics, abandoned nets and any other litter that is collected in their nets during normal fishing activities. When they reach the port, they will unload the collected litter at certain points, from where they will be collected during a certain period and will be transported for subsequent recycling or disposal. They can do this voluntarily or in exchange for certain incentives.

REFERENCES

Awareness campaign on marine litter, Urban Waste, 10 pp.

Bobchev, N., 2018. Concentration, seasonal variation and composition of marine litter at the coast of the Black Sea: A case study of the Ropotamo beach in the natural reserve of Ropotamo. https://www.researchgate.net/publication/327667864_Koncentracia_sezonni_kolebania_i_raznovidnost_na_morskite_otpadci_po_Blgarskoto_Cernomorie_i_tahnoto_detajlno_razglezdane_pri_ustieto_na_reka_Ropotamo

Eriksen, M., Lebreton, L.C.M., Carson, H.S., Thiel, M., Moore, C.J., Borerro, J.C., Galgani, F., Ryan, P.G., Reisser, J., 2014. Plastic pollution in the World's oceans: more than 5 trillion plastic pieces weighing over 250,000 tons afloat at sea. PLoS One 9 (12), e111913. https://doi.org/10.1371/journal.pone.0111913.

Eriksson, C., Burton, H., Fitch, S., Schulz, M., van der Hoff, J., 2013. Daily accumulation rates of marine debris on sub-Antarctic island beaches. Mar. Pollut. Bull. 66, 199–208. Eunomia, 2016. Plastics in the Marine Environment. Eunomia Research & Consulting Ltd, Bristol, United Kingdom Available fr

Final report on the implementation of Lot 1 "Identification of hotspots of solid waste pollution in the target area" of the public procurement "Selection of a contractor to identify hotspots and model the distribution of solid marine litter in the target area (Bulgarian Black Sea coast) ", Higher Naval School" Nikola Y. Vaptsarov ", 70 p.

Final report on the implementation of lot 2 "Model of water flows and distribution of solid waste in the target area" of the public procurement "Selection of contractor for identification of hotspots and modeling of the distribution of solid marine waste in the target area (Bulgarian Black Sea coast) ", Higher Naval School" Nikola Y. Vaptsarov ", 111 p.

Final Report on Implementation of Lot 2 "Study of the current state of a selected part of the Black Sea and the type and distribution of waste in it (Bulgaria) and Monitoring of marine litter in a selected part of the Black Sea coast", Higher Naval School "Nikola J. Vaptsarov ", 167 p.

Guidance on Monitoring of Marine Litter in European Seas, European Commission, MSFD Technical Subgroup on Marine Litter, 2013, 128 pp

Haarr, Marthe Larsen; Westerveld, Levi; Fabres, Joan; Iversen, Kriss Rokkan; Busch, Kjersti Eline Tønnessen (2019). *A novel GIS-based tool for predicting coastal litter accumulation and optimising coastal cleanup actions. Marine Pollution Bulletin, 139(), 117–126.* doi:10.1016/j.marpolbul.2018.12.025

Kataoka, Tomoya; Hinata, Hirofumi (2015). *Evaluation of beach cleanup effects using linear system analysis. Marine Pollution Bulletin, 91(1), 73–81.* doi:10.1016/j.marpolbul.2014.12.026

Marine Debris Monitoring and Assessment: Recommendations for Monitoring Debris Trends in the Marine Environment NOAA Marine Debris Program National Oceanic and Atmosphereic Administration U.S. Department of Commerece Technical Memorandum NOS-OR&R-46 November 2013

Marine Litter Technical Recommendations for the Implementation of MSFD Requirements EUR 25009 EN - 2011 MSFD GES Technical Subgroup on Marine Litte

Monitoring of two beaches south of Varna within the activities of the project MELTEMI - Methodology and monitoring, https://meltemi.bsnn.org/docs/BSNN_MELTEMI%20monitoring.pdf

Moy, K., Neilson, B., Chung, A., Meadows, A., Castrence, M., Ambagis, S., Davidson, K., 2017. Mapping coastal marine debris using aerial imagery and spatial analysis. Mar. Pollut. Bull. https://doi.org/10.1016/j.marpolbul.2017.11.045. Ocean Conservancy, 2016. 30th anniversary international coastal cleanup. Report available from: https://oceanconservancy.org/wp-content/uploads/2017/04/2016- data-release-1.pdf

OSPAR, Action 43 Study to identify and assess relevant instruments and incentives to reduce the use of single-use and other items, which impact the marine environment as marine litter, Economics for the Environmental Consultancy, 95 pp.

Protecting the marine environment - A guideline with good practices for reducing solid waste at sea and along the coast, 2016, ISBN 978-954-9452-17-4, 79 pp.

Report on position 1 „Providing data for water currents and connected with them waste streams in the Black Sea“, 76 pp

Solid waste in the marine environment - Opportunities for optimizing the legal framework, Burgas Association of Eco and Rural Tourism, January 2015, 4 pp.

Toneva D., T. Stankova, D. Dimova, D. Ralcheva, RESEARCH ON MARINE BEACH LITTER AT BURGAS BAY REGION DURING AUTUMN 2019 Д. Тонева, Станкова Т., Димова Д., Ралева Д., Проучване на морските отпадъци, отложени по брега в района на Бургаски залив през есента на 2019, Устойчиво развитие, 3/2019, 18-22

UNEP/IOC Guidelines on Survey and Monitoring of Marine Litter, Regional Seas Reports and Studies No. 186 IOC Technical Series No. 83, 131 pp

Utkina, K., Kresin, V., Brook, V., Iakovleva, N., Komorin, V., Velikova, V. And G. Avaz. 2015, Hot Spots Methodology: Guiding harmonization in identification and prioritization of Hot Spots in the Black Sea Region. HBS Project (http://bs-hotspots.eu/) publications. 45 pp.

Vegter, A.C., Barletta, M., Beck, C., Borrero, J., Burton, H., Campbell, M.L., Costa, M.F., Eriksen, M., Eriksson, C., Estrades, A., et al., 2014. Global research priorities to mitigate plastic pollution impacts on marine wildlife. Endanger. Species Res. 25, 225–247. Zampoukas, N., Piha, H., Bigagli, E., Hoepffner, N., Hanke, G., Cardoso, A.C., 2012. Monitoring for Marine Strategy Framework Directive: requirements and options. In: JRC Scientific and Technical Reports No. 070307/2010/579669/AA/D2,

Yaneva V., Simeonova A., Toneva D., Vladimirova Zh., Hristova R., 2016 Investigation of marine litter along the shoreline of the New Channel "Varna Lake - Black Sea ISSN 1310-5833, (3) (PDF)

ANNEXES

Annex №	Name
Annex 1.	Analysis of data provided by Burgas Municipality about the occurance of the main categories of marine litter on beaches
Annex 2.	Field form for identification of hotspots
Annex 3.	Photo guide for visual identification and classification of marine litter categories / subcategories