

2014 - 2020 Interreg V-A  
Italy - Croatia CBC Programme  
Call for proposal 2019 Strategic

## MARLESS (MARine Litter cross-border awareNESS and innovation actions)

Priority Axis: Environment and cultural heritage; Specific objective: 3.3 - Improve the environmental quality conditions of the sea and coastal area by use of sustainable and innovative technologies and approaches

### 3.1.2 – Presentations created by each one of the technical partner of the methods used in their region

3.1

WP3

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## PROJECT MARLESS

<b>Work Package:</b>	<b>WP3 – Monitoring optimization</b>
<b>Activity:</b>	<b>3.1 – Harmonization of the monitoring plan and methodology</b>
<b>WP Leader:</b>	<b>Autonomous Region Friuli-Venezia Giulia – PP2</b>
<b>Deliverable:</b>	<b>3.1.2 - Presentations created by each one of the technical partner of the methods used in their region</b>

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# WP3

## **Deliverable 3.1.2.**

Presentation of the methods used in HR and IT

# WP3

## **Deliverable 3.1.2.**

Presentation of the methods used in IT

# ISPRA – MARINE STRATEGY METHODOLOGY - ITA

MARLESS | ARPAV | Andrea Torresan

TG meeting | Online | 14/04/2021

# FLOATING LITTER

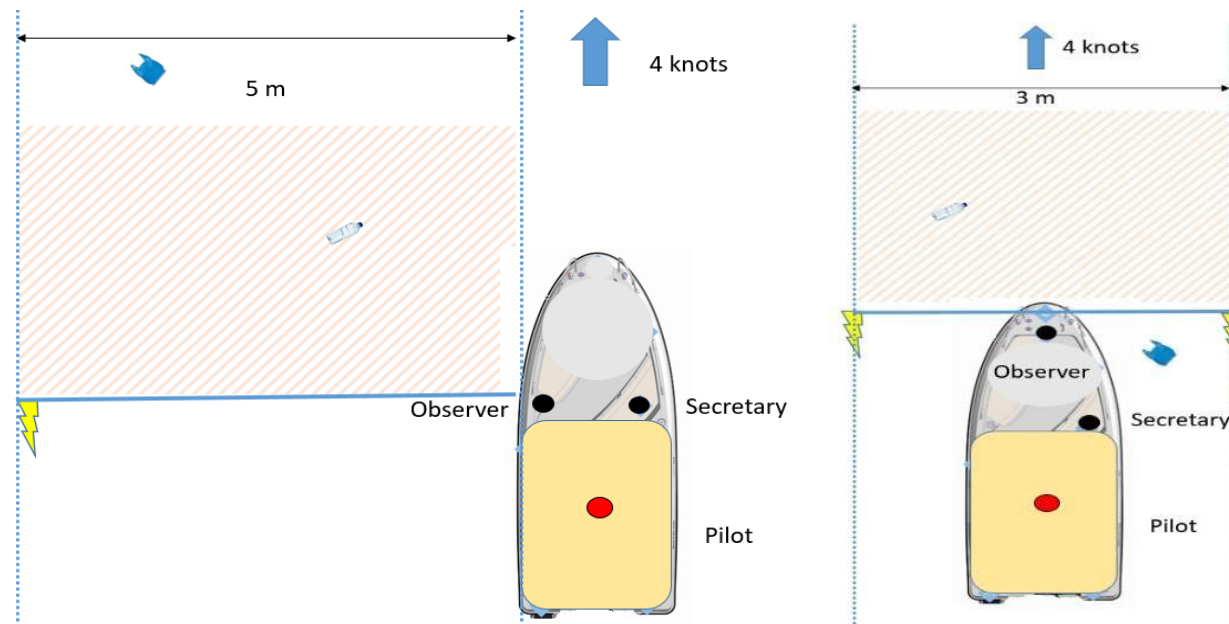
## Visual Census of the Floating Litter

Speed: 4knots

Width: 3/5m – depends on the boat

Gps point start/end in order to identify the area of the survey

Category size: **B** 2.5-5 **C** 5-10 **D** 10-20 **E** 20-30 **F** 30-50 **G** 50-100 **H** >100



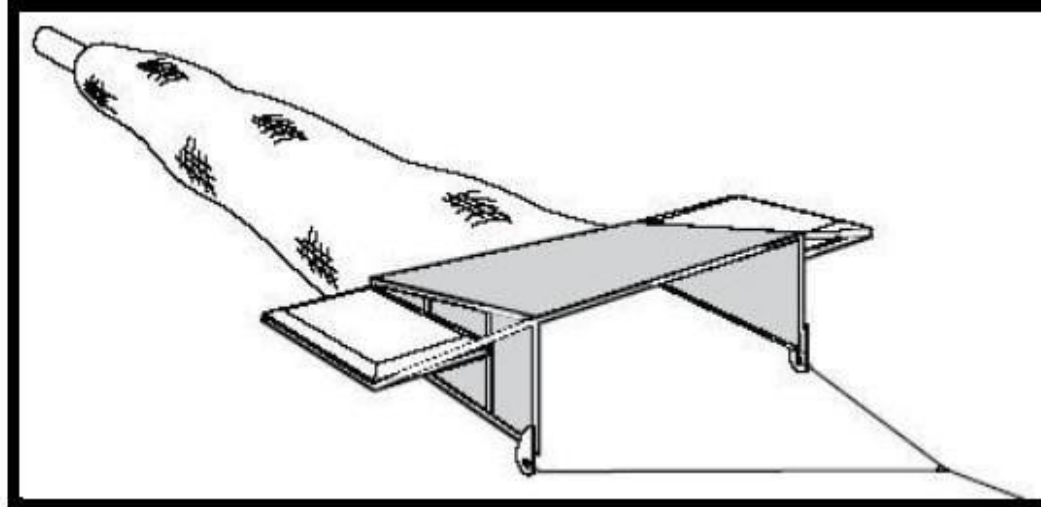
# MICROPLASTIC LITTER

**Mouth size and length:** not predetermined, they depend on the towing boat. It is, however, advisable to always maintain a ratio equal to  $\frac{1}{2}$  between height and width of the mouth.

**Mesh of the net:** approximately 330  $\mu\text{m}$

**Sampling mode:** at least 3 sampling stations located at different distances from the coastline (i.e. 0.5, 1.5, 6 Naut. Miles) along transects that are orthogonal to the coastline – **Speed 2 Knots for 20 minutes**

**Unit of measure :** the microplastic concentration in the sample, in terms of shape and colour, is expressed as the number of objects per  $\text{m}^2$  of sampled seawater



# BEACH LITTER

## Sampling

*Length:* 100m

*Width:* from the shoreline up to the limit of the vegetation or the costal dunes

Object above 2,5cm + all cigarette butt





# Thank you



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# WP3

## **Deliverable 3.1.2.**

Presentation of the methods used in HR

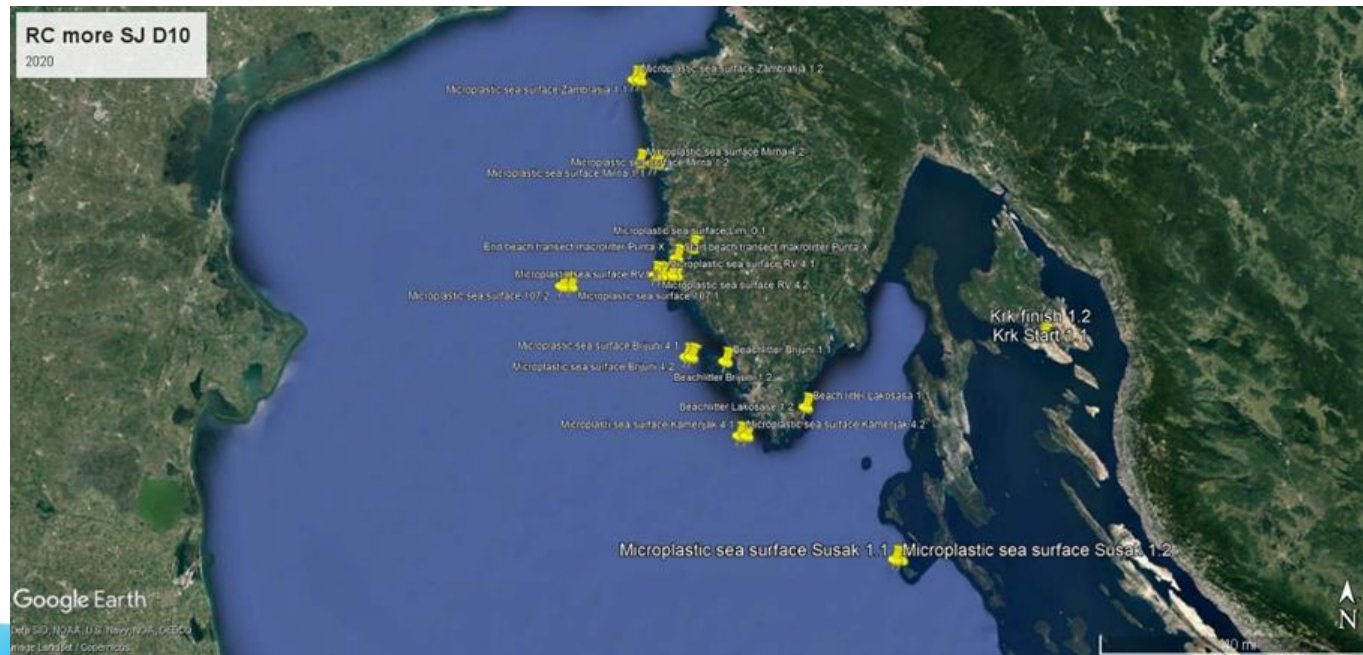
# Presentation of the methods for marine litter monitoring used in Croatia (HR)

MARLESS | PP7 | Ruđer Bošković Institute  
Centre for Marine Research Rovinj

Meeting WP3 Technical Group | 14 April 2021

# Marine Litter Monitoring in Croatia

- Marine Litter on Beaches Macro-Debris (>2.5cm)
- Marine Litter in Beach Sediment
- Marine Litter on the Sea Surface
- Marine Litter on the Seafloor
- Microplastics on the Sea Surface
- Marine Litter in Biota



# Methodology for Monitoring Marine Litter on Beaches Macro-Debris (>2.5cm)

## Site selection:

The sites are selected randomly taking into consideration certain criteria.

- Have a minimum length of 100 m
- Have clear access to sea
- Be accessible to survey teams throughout the year
- Ideally not be subject to cleaning activities

Pre-survey characterization of sites (GPS coordinates, characterization of the type of substrate, etc.)

## Sampling units

- A sampling unit is defined as a fixed section of a beach covering the whole area from the strandline to the back of the beach.



# Methodology for Monitoring Marine Litter on Beaches Macro-Debris (>2.5cm)

## Frequency and timing of surveys:

Two surveys per year:

- Outside the touristic season
- During the touristic season

## Size limits to be surveyed

There are no upper size limits to litter recorded on beaches. Litter items with a lower limit of 2.5cm



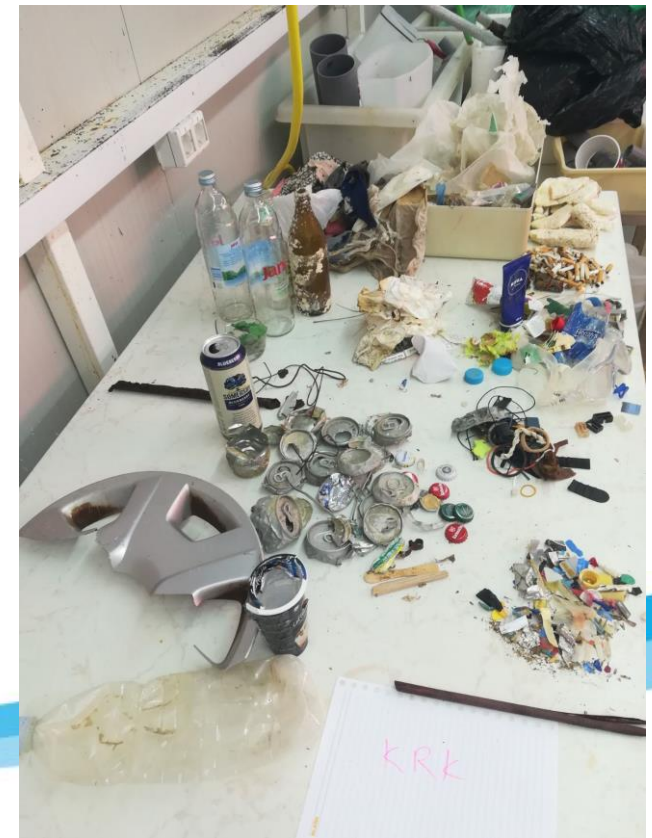
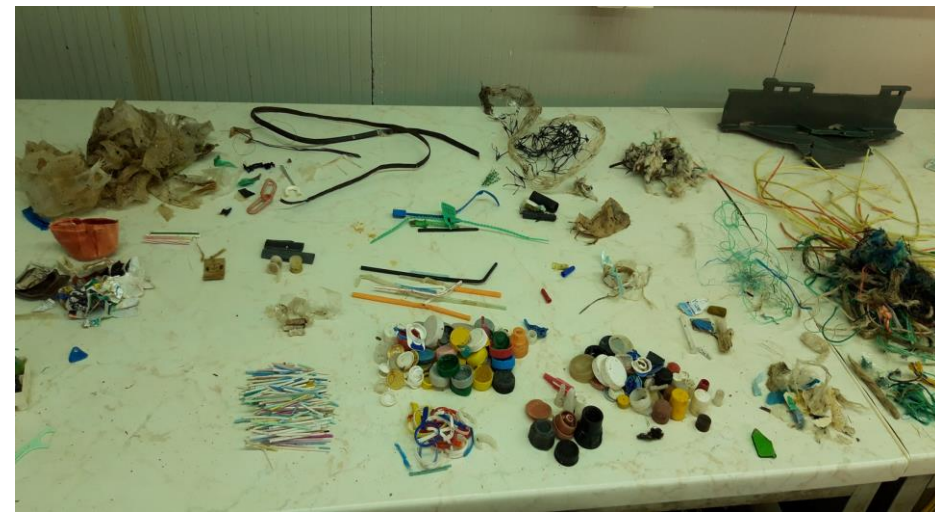
# Methodology for Monitoring Marine Litter on Beaches Macro-Debris (>2.5cm)

## Collection and identification of litter

- All items found on the sampling unit should be entered on the 'Beach Litter Monitoring Sheet'. On the sheet, each type of item is given a unique identification number (most precise as possible)
- All litter items should be removed from the beach during the survey
- Larger items that cannot be removed (safely) by the surveyors should be marked and documented with a photo

## Quantification of litter

- The unit in which litter will be assessed on the coastline will be number of items and it will be expressed as counts of litter items per square meter (item/m<sup>2</sup>)
- In addition, the main category types of litter items should be weighed.



# Methodology for Monitoring Marine Litter on the Sea Surface (Visual observation)

## Site selection

- Low density area
- High density area
- Other

## Survey area

- The survey area is defined by the transect width and length.
- The transect width depend of the observation level above the sea ( eg. 1m → 6m)
- Speed of 2 knots
- The length is determined from latitude and longitude (GPS)





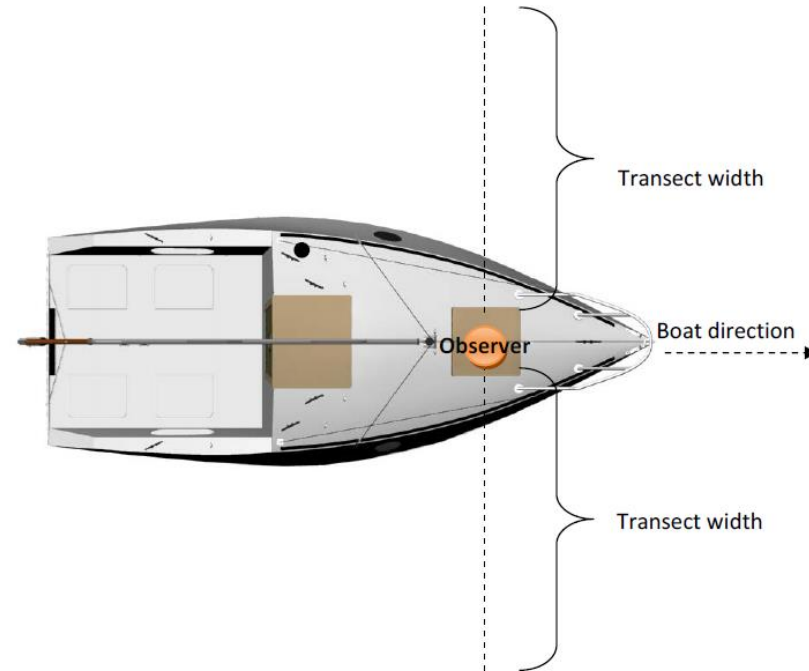
# Methodology for Monitoring Marine Litter on the Sea Surface (Visual observation)

## Frequency and timing of the survey

- Two surveys per year:
- Outside the touristic season
- During the touristic season

## Visual observation

- Detection of items in the size range of 2.5 – 50 cm.
- Made by a dedicated person
- Time 20 min to 1 hour
- Avoid sunrise and sunset (low visibility)



# Methodology for Monitoring Marine Litter on the Sea Surface (Visual observation)

## Size limit and classes

- Category size of litter

- A. 2.5cm-5cm
- B. 5cm-10cm
- C. 10cm-20cm
- D. 20cm-30cm
- E. 30cm-50cm
- F. >50cm

## Identification of litter

- All items found on the sampling unit should be entered on the 'Floating Litter Monitoring Sheet'. On the sheet, each type of item is given a unique identification number (most precise as possible)

## Quantification of litter

- The unit in which litter will be assessed will be number of items and it will be expressed as counts of litter items per square kilometer (item/km<sup>2</sup>)

# Methodology for Monitoring Marine Litter on the Seafloor

## Bottom trawl surveys and scuba diving

Two methods

- Bottom trawl (continental shelf)
- Scuba diving (up to 20 m depth)

## Site selection

- Selecting sites that meet certain criteria (e.g. are close to ports, river mouths, cities, etc.)
- Choose randomly

## Survey area

- Length 500 – 1000 m (bottom trawl)
- Length 50 – 200 m minimum 2 transects (Scuba diving)



# Methodology for Monitoring Marine Litter on the Seafloor

## Bottom trawl surveys and scuba diving

### Frequency and timing of the survey

- Two surveys per year:
- Outside the touristic season
- During the touristic season



### Trawling operation

- Constant depth
- Duration 30 min
- Speed 3 knots

### Scuba diving

- The length of the line transects vary between 50m-200m and the width from 4-8m, depending on the depth, the depth gradient, the turbidity, the habitat complexity and the litter density

# Methodology for Monitoring Marine Litter on the Seafloor

## Bottom trawl surveys and scuba diving

### Size limit and classes

- Category size of litter

- A.  $< 5\text{cm} * 5\text{cm} = 25\text{cm}^2$
- B.  $< 10\text{cm} * 10\text{cm} = 100\text{cm}^2$
- C.  $< 20\text{cm} * 20\text{cm} = 400\text{cm}^2$
- D.  $< 50\text{cm} * 50\text{cm} = 2500\text{cm}^2$
- E.  $< 100\text{cm} - 100\text{cm} = 10000\text{cm}^2 = 1\text{m}^2$
- F.  $> 100\text{cm} - 100\text{cm} = 10000\text{cm}^2 = 1\text{m}^2$

### Identification of litter

- All items found on the sampling unit should be entered on the 'Benthic Monitoring Sheet'. On the sheet, each type of item is given a unique identification number (most precise as possible)

### Quantification of litter

- The unit in which litter will be assessed will be number of items and it will be expressed as counts of litter items per square kilometer (item/km<sup>2</sup>)

# Methodology for Monitoring Microplastics on the Sea Surface

## General consideration

- Weather condition: the wind speed should not be more than 2 Beaufor (the wave high should not be more than 0.5 m).
- The travel speed should be between 2 – 3 knots.
- Duration of sampling should be for 30 min. (in case of huge amount of natural material, e. g. plankton bloom, the duration of sampling could be shorter).
- Use of Manta Net (300  $\mu\text{m}$ ) with flowmeter



# Methodology for Monitoring Microplastics on the Sea Surface

## Sample preparation and analyses

- Pour sample through the sieve ( $\leq 300 \mu\text{m}$  mesh size) and store in EtOH 70%
- Remove all natural or artificial litter objects of size  $> 5 \text{ mm}$  (macro and mezzo litter) from the sample
- Visual identification and tweezers (stereomicroscope)
- Item/dm<sup>3</sup> and Item/m<sup>2</sup>

Micro litter categories
Fragments (G103, G104, G105, G106)
Pellets (G107, G108, G109, G110, G111)
Granules (G116)
Filaments (G113)
Films (G114)
Foam (G115, G117)
Other (nonplastic materials) (G217)
Uncategorized plastic pieces*

Colour of plastic items
White
Clear-white-cream
Red
Orange
Blue
Black
Grey
Brown
Green
Pink
Tan
Yellow



# Methodology for Monitoring Marine Litter in Biota

- The samples are frozen immediately after capture and are transported to the laboratory.
- Record: length, weight, sex and maturity
- Dissection (weight of sample)
- Digestion (30% H<sub>2</sub>O<sub>2</sub>, approximately 50 ml of 30% H<sub>2</sub>O<sub>2</sub> per gram wet weight, 60 °C)
- Separation via flotation in 100 mL concentrated saline solution and filtered (dry filter)
- Filters are examined for microplastics under a stereomicroscope. Number of items as well as size (longest diagonal), color and shape is recorded.
- Frequency of occurrence (%F) and percentage numerical abundance (%N)



G103	Plastic fragments rounded <5 mm
G104	Plastic fragments subrounded <5 mm
G105	Plastic fragments subangular <5 mm
G106	Plastic fragments angular <5 mm
G107	Cylindrical pellets <5 mm
G108	Disks pellets <5 mm
G109	Flat pellets <5 mm
G110	Ovoid pellets <5 mm
G111	Spheruloids pellets <5 mm
G113	Filament <5 mm
G114	Films <5 mm
G115	Foamed plastic <5 mm
G116	Granules <5 mm
G117	Styrofoam <5 mm
G217	Other (glass, metal, tar) < 5 mm

Transparent
Crystalline
White
Clear-white-cream
Red
Orange
Blue
Opaque
Black
Grey
Brown
Green
Pink
Tan
Yellow




# CONTACT INFORMATION


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## WP3

### **Deliverable 3.1.2. - Sharing existing IT and HR methods (in EN language)**

# WP3

## **Deliverable 3.1.2.**

Sharing existing IT methods

# Monitoring of Beach Litter

## **BOX 1 – Beach selection criteria**

The following areas should be monitored for at least one beach in each Region:

- built-up areas;
- river mouths;
- harbour areas or areas that are nevertheless indicative of pollution from waterborne transport and fishing;
- remote areas that are not directly accessible to land transport, or that are located in protected areas.

The spatial distribution of the beaches for each Region must be representative of the coastline and the different sub-regions to which they belong, in the case of Regions that span cross two different Sub-regions.

The beaches should:

- be composed of sand or gravel and exposed to the open sea (without any breakwater barriers);
- be accessible to surveyors all year round;
- be accessible for ease of marine litter removal;
- be a minimum length of 100 m;
- be free of 'buildings' during the survey period;
- preferably over 1 km in length;
- preferably not be subject to any other litter collection activities during the year.

The position of the beach is identified by the centroid of the transect (or sampling unit). The centroid (located via GPS and expressed in sexagesimal degrees GG°,GGGGG in the WGS 84 coordinate system), the physical and geographical characteristics and other information regarding any surrounding sources of pollution such as rivers, inhabited centres, etc. are reported in the *Beach Identification Record* and can be acquired once only, unless there are significant changes over time, such as the construction of a new wastewater discharge.

Note: the sources previously identified as "River mouths or water discharges" and "Industrial sites/landfills" have now been divided into: "River mouth", "Wastewater discharge", "Industrial site" and "Landfill" and must therefore be calculated again (once only at the first sampling in 2020) for all beaches that are monitored.

# SAMPLING PROTOCOL

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## Sampling frequency

Each transect (or sampling unit) is monitored twice a year during the following time intervals so as not to coincide with the tourist season or periods of adverse marine weather conditions:

1. from February 1 to April 30 (Spring)
2. from October 1 to December 31 (Autumn)

To correctly record the sampling data in the database, a unique code is assigned as follows:

Sampling Code = BEACH CODE\_YEAR\_SEASON CODE

The beach code is shown in table 2, whereas the season code is shown in tab 3.

Table 3 – Season codes

SEASON	SEASON CODE
Spring	1PRI
Autumn	2AUT

## Sampling area

Sampling of beached waste or marine litter is carried out within a single transect, which is a **100 m** stretch of beach whose centroid is as close as possible to that of the three 33 m areas sampled in previous years (2015-2019) (Fig. 1).



Fig. 1 – (A) Sampling up to 2019: three 33m areas (in pink). (B) New sampling (from 2020): single 100 m transect (in yellow). The centroid (black X) of the new transect closely matches the centroid of the three 33 m areas of the previous cycle of surveys.

The sampling area covers the entire width of the beach, from the water edge to the dune system or vegetation and/or any construction present (e.g. roads) (Fig. 2).

**The transect must be as accurate as possible to site previously surveyed and the same year after year.**

### Information relating to each sampling

At each sampling, the following are measured and recorded in the *Marine Litter Monitoring Survey Form* (annex 4.3):

- the start and end point of the transect, measured at half its width (Fig. 2) (sexagesimal degrees GG°,GGGGG; WGS 84 coordinate system);
- the exact length of the transect being monitored (must be 100 m except for exceptional cases), identified as the distance between the start and end point of the transect measured at half the beach width (Fig. 2);
- the width of the transect (perpendicular to the water edge) defined as the distance between the water edge and the back of the beach (dune system or constructions) and measured at half its length (Fig. 2);
- the date of any beach cleaning actions prior to survey sampling by the persons in charge or in the context of population awareness campaigns, volunteering, etc.;
- unconfirmed evidence of a possible cleaning event prior to the survey;
- known events (e.g. heavy storms, extreme weather conditions, rivers in full spate, etc.) that have led to changes in the sampling protocol (such as transect length or displacement, sampling outside the forecast period, sub-sampling, etc.);
- known events that could have caused an unusual presence of waste (due to abundance, type, etc.).



Fig. 2 – Positioning and measurement of the transect (blue area). Measurement of the length and width in yellow. The red dots are the start and end points of the transect that must be georeferenced.

Legend:

Limite vegetazione o manufatti	Edge of vegetation or construction
Punto inizio / Punto fine	Start point / End point
Profondità	Width
Lunghezza	Length
Battigia	Water edge

## Survey method

### *What to monitor*

All visible elements exceeding 2.5 cm in size (longest side) on the beach. Even if cigarette butts are smaller, they must nevertheless be considered.

### *The monitoring procedure*

Sampling is performed by proceeding in a systematic manner orthogonally or parallel to the water edge (Fig. 3) at approx. 2 m apart. In the event of adverse weather conditions or other events that could interrupt the sampling earlier than expected, then the method outlined in Fig. 3B is recommended.

No digging into or moving the sand to search for objects.

Objects are identified individually according to the categories listed in the *Joint List* (Annex 4.2) and recorded on site (Box 2) in the *Marine Litter Monitoring Survey Form*. If there are unusual or unknown objects, a photo is taken.

Note: marine litter or beached waste is legally classified as municipal solid waste<sup>1</sup> and consists for the most part of everyday objects that can be handled with latex or gardening gloves. However, it is recommended to provide operators with cut-resistant gloves and telescopic litter pickers to handle any sharp or dirty objects.

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<sup>1</sup> Art. 184, point 2 of Legislative Decree 152/06 classifies municipal solid waste as "waste of any nature or origin, on roads and in public areas or on roads and in private areas, nevertheless subject to public use or on seashores and the shores of lakes and watercourses".

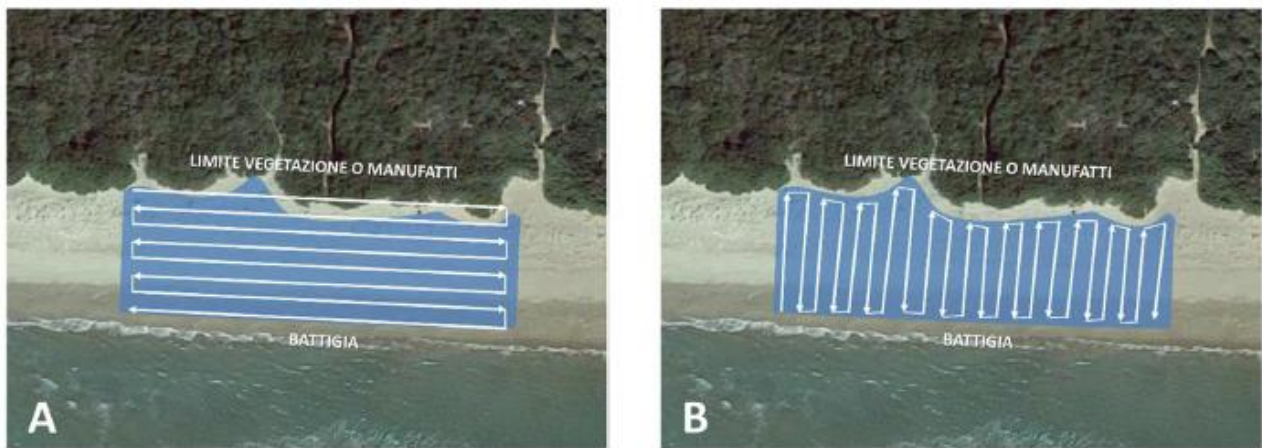


Fig. 3 – Possible sampling methods at 2m apart, parallel (A) or perpendicular (B) to the water edge.

Any litter/waste that is found and recorded, must be collected and disposed of.

Larger objects that cannot be taken away by the survey fieldworkers must be marked so that they are not counted again during the next monitoring survey. They should be recorded on the monitoring survey form the first time they are found only.

Dangerous or suspicious-looking items, such as chemicals or their containers, fuel, drums or flammable substances, sharp or particularly heavy or bulky objects should not be removed. Instead, after taking note of the coordinates of the critical object or certain and precise references for it to be easily retrieved the responsible authorities should be informed so that they can handle and dispose of it safely according to the provisions of law.



It is understood that, unless otherwise agreed with other institutional subjects (municipalities, municipal waste companies, etc.) who can provide their own personnel or suitable containers to collect special waste in the place and on the day of the monitoring survey, handling and collection by operators must refer and be limited only to the categories of objects that can be easily sorted into recyclable/non-recyclable waste collection containers or taken to the Waste Recycling Centre if transported safely in compliance with the law.

### BOX 2 – Filling in the Marine Litter Monitoring Survey Form

The new field form consists of 7 pages and includes: fields for recording sampling data, a list of codes and descriptions of the most common waste categories (primary list) divided by material, a list of codes and descriptions of least common waste categories (secondary list) divided by material<sup>2</sup>, an area to record the number of objects per category and any photos taken.

Individual objects can be recorded on the form as the fieldworker proceeds through the survey area and comes across them. “Tally marks” (one bar per object) can be used on the form to record the number of objects. For the sole purpose of facilitating identification of the categories and recording the data, the borders are thicker, and colours have been used (however, it is advisable to eliminate the coloured background if printing in B/W) to group the categories by «similarity» (bags, food, caps/lids, smoking, work, fishing, etc.).

The sheet can be customized by the individual ARPA (Regional Environmental Protection Agency) e.g. moving any category from the primary to secondary list or vice versa and/or highlighting the objects that are most frequently found according to the specific regional characteristics.

*Example of field recording data.*

ARTIFICIAL POLYMERS		
<b>G3</b>	Shopping bags, black dustbin bags	
<b>G4</b>	Small plastic bags, e.g. freezer bags	
<b>G5</b>	Remaining part of tear-open bags	
<b>G7</b>	Bottles and plastic containers for beverages <= 0.5 L	
<b>G8</b>	Plastic bottles and containers for beverages > 0.5 l	

On the last page additional data can be recorded, such as photographs that have been taken: especially of bulky or dangerous objects, trapped animals, nationality of the waste, expiry date on the package, etc.

<sup>2</sup> The categories are divided into two lists, i.e. primary and secondary, to facilitate the fieldworker; they are not separate in the database.

We do not recommend printing the form on both sides

Note: in very exceptional cases, when there are quantities of litter such that it is not reasonably possible to count every item in the transect, to obtain a numerical estimate of the objects for each category<sup>3</sup>, a sub-sample of the area following one of the two methods suggested in Box 3 can be taken. These sampling methods, however, cannot in any way replace the protocol envisaged, but can be implemented only and exclusively if there are exceptional events and at the discretion of the operators present on site.

### *Optional surveys*

From a comparison between ARPA (the Regional Environmental Protection Agency) and ISPRA (the Italian National Institute for Environmental Protection and Research) other useful information can be collected on beached waste during the survey on an optional basis, namely:

#### Trapped animals

Animals trapped in marine litter may also be reported when these are spotted along the beach in other areas outside the transect. The data can be recorded by taking a photo and then writing a description in the 'Photo' sheet in the 'Description' field.

#### Country of origin

When visible, the country of origin of the object can be recorded by taking a photo of the object and writing the origin in the 'Photo' sheet in the 'Country of Origin' field.

#### Best Before Date

When visible, the expiry date of the food shown on the package can be recorded by taking a photo of the object and then recording the identified date on the 'Photo' sheet in the 'Best Before Date' field.

#### Origin of the waste

When the origin of the object can be determined with reasonable certainty ("beached", "deposited on the ground" or "of undetermined origin") it can be recorded with a letter or symbol placed near the tally mark. When filling in the database ('Field Waste' sheet) different lines must be filled in per number of objects of a given category identified as beached, identified or as deposited on the ground, and a line must be completed for each of these.

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<sup>3</sup> Qualitative information (e.g. "more than 100", "impossible to count", "> 100", etc.) or classes (e.g. "between 100 and 1000") in fact result in the loss of data.

### BOX 3 – Suggested sampling methods when there are exceptional quantities of waste

When there is an exceptionally high amount of waste in the transect area and it is impossible to classify all the objects, a numerical estimate can be obtained by sampling a part (sub-sample) of the transect (Method A) or a part of the area where most of the waste has accumulated (Method B). In both cases, any modification to the protocol must be clearly described on the field sheet. Whenever possible, photographs of the areas where waste has accumulated is recommended.



#### Method A

This method should be used when **the entire length of the transect is affected by exceptional quantities of waste (in red) distributed evenly**. The sub-sample consists of a portion of the transect of no less than 20 m in length and includes the entire width of the beach, from the water edge to the dune, vegetation or construction system (blue area).

1. accurately measure the length of the sub-sample to be monitored (yellow arrow) and record it on the sheet; 2. classify **all** objects in the sub-sample area.

**Note: the number of objects actually counted must be entered in the database, without further numerical processing, and the length of the sub-sample actually monitored (yellow arrow) on the 'Sample Beach' sheet.**



#### Method B

This method should be used when an **exceptional accumulation of waste (in red) is concentrated in a single area of the transect (accumulation area)**. The sub-sample consists of a part of the accumulation area (in green).

1. sample the whole transect area regularly, except for the accumulation area; 2. measure the accumulation area; 3. measure the sub-

sample in the accumulation area; 4. classify **all** the objects present in the chosen sub-sample area (green area); 5. estimate by proportion the number of objects per category in the accumulation area ( $n^\circ$ . of objects in the sub-sample x accumulation area / sub-sample area); 6. add (by category) the estimated number of objects in the accumulation area to the number of objects in the remaining part of the transect, which have been regularly monitored.

**Note: the estimated number of objects as described must be entered in the database and the length of the entire transect on the 'Sample Beach' sheet.**

## Additional notes

Arrangements should be made with the local municipalities so that monitoring of the reference beach does not coincide with their cleaning schedules as this would interfere with the survey results. In any case, having acknowledged the frequency with which the beaches are cleaned by third parties and the difficulty reported by ARPA in finding information on the cleaning, it is suggested that the monitoring of marine litter by placing signs in the immediate vicinity of the surveyed area (or where it is considered more appropriate). ISPRA will notify the local Legambiente and other organizations of the survey sites so that the cleaning campaigns/monitoring by volunteers (e.g. Clean Up the Med) are not carried out at the transects monitored by ARPA.

The sign wording and graphics are provided by ISPRA (Annex 4.4); the sign must be modified, printed or produced by the regional ARPA that carries out the monitoring.

## Annexes

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<b>ANNEX 4.1</b>	Beach identification sheet
<b>ANNEX 4.2</b>	Categories of beached waste and litter ( <i>Joint List</i> )
<b>ANNEX 4.3</b>	Marine Litter Monitoring Survey Form
<b>ANNEX 4.4</b>	Signs

# WP3

## **Deliverable 3.1.2.**

Sharing existing HR methods

## **1. Marine litter**

### **1.1. Previous knowledge about marine litter in the Adriatic sea under the sovereignty of the Republic of Croatia**

Because of the lack of systematic studies and monitoring programmes of marine litter in the Adriatic sea under the sovereignty of the Republic of Croatia, previous activities related to the issue of marine litter have mostly been limited to periodical analyses of floating litter and litter stranded on beaches (Kwokal and Štefanović, 2009, 2010; Petricioli and Bakran-Petricioli, 2012), as well as research about sea turtles ingesting marine litter (Buršić et al., 2008; Lazar et al., 2011). Floating litter most often accumulates on the southern coastal areas as a result of winds blowing in the southern direction and sea currents transporting the litter to great distances. During recent years, cases of excessive marine pollution by solid floating litter have been recorded in the Republic of Croatia, especially in the southern Adriatic sea (Dubrovnik-Neretva county), where the litter was brought by sea currents from the southern Adriatic and the Neretva river. Solid litter that reaches the marine environment differs in its origin, use, composition, size, shape, durability and ecological “acceptability”, with the main categories of litter being different types of plastic, metal, glass, rubber and paper. There is no systematic gathering and recording of marine litter data in the Republic of Croatia, nor any type of strategic document/legal act which refers exclusively to this type of litter. Activities related to marine litter prevention are carried out through the application of the existing legal framework and strategic documents related to litter management.

### **1.2. The purpose and goals of the marine litter monitoring programme**

Because of different categories of marine litter, a protocol selection should precede defining the purpose and goals of marine litter monitoring programme since different categories of litter require different approaches in developing monitoring programmes. The basic goals of monitoring under the Marine Strategy Framework Directive (MSFD) are set out in the Directive itself in Chapter 2.1. It is necessary to assess if a good marine environment condition (GEC) has to be accomplished or only maintained, as well as if the environment is in a stable condition, i.e. is the condition getting better or worse. Additionally, it is necessary to assess the progress towards achieving the goals of environmental protection according to GEC.

All the methods/protocols suggested in the relevant guidelines are primarily designed for monitoring the condition of the environment and the progress in accomplishing GEC. Because of the current lack of knowledge about the level of adverse impacts of marine litter it is difficult to define impact levels of the litter which results in many European Union member states setting up contemporary goals. According to the Guidelines, some of the listed goals which need to be defined are: assessment of the current condition of the marine environment and temporal and spatial trends of such condition, monitoring achievement progress of the defined goals for marine litter, determining the source of marine litter, monitoring the efficiency of conducting the measures. All of the monitoring goals have to be linked to the guidelines and goals of GEC, as well as the goals defined for the marine litter descriptor.

### 1.3. Selected sampling areas and sampling frequency

Monitoring the condition of an individual indicator generally depends on the level of existing knowledge and availability of the basic data of every individual indicator. Since there is generally little data about the current condition, amounts, properties and impacts on the marine environment for most indicators for the area of eastern Adriatic coast, and for some of them there is a complete lack of data, current knowledge at the present level is not enough for implementing a monitoring programme. Consequently, it would be necessary to first conduct research monitoring for all the indicators where basic data for making the decision about the future complete monitoring would be gathered through a pilot project. In addition, it is necessary to take into account the possibility of changing the monitoring programme through improvements in the form of changing the criteria and number of locations, sampling frequency and wherever needed, based on obtaining new knowledge and information. After that it would be necessary to estimate the level of readiness for implementing monitoring programme for individual indicators. A proposal of dynamics on research monitoring is presented in Table 1.3.1.

*Table 1.3.1.* Indicators, areas and frequency of marine monitoring.

Monitoring	Area	Frequency
Monitoring amount and composition of litter stranded on the coast	South-oriented coastal areas in south, middle and north Adriatic  Deltas of large rivers, especially Neretva  Sand beaches	Seasonal  4 times a year (spring, summer, autumn, winter)
Monitoring amount and composition of litter on the marine surface and the seabed	Main routes of ferry lines and nautical routes, south-oriented coastal areas in south, middle and north Adriatic  Main trawling areas	Seasonal  2 times a year (spring and autumn)
Monitoring amount and composition of microplastic on beaches and marine surface	Selected sand beaches, especially in south, middle and north Adriatic  Main trawl net fishing areas, vicinity of wastewater discharge	Seasonal  4 times a year (spring, summer, autumn, winter)
Monitoring amount and	Important fishing areas	Seasonal

composition of ingested marine litter		4 times a year (spring, summer, autumn, winter)
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#### 1.4. Selected indicators with explanation

Although the issue of marine litter has been present for a long time, our knowledge about it is still scarce. The main limitations are the inexistence of a large-enough database containing the amounts, composition and trends of marine litter, poor knowledge of oceanographic and climatic processes which affect distribution of marine litter, and of the further fate of the litter after reaching the marine environment (degradation time, time needed to reach the seabed etc.). Currently, there is no coordinated monitoring programme developed on a national or regional level which would monitor the amount of the litter or microplastic on the sea surface, in a water column or on the seabed. Data that are gathered are related to smaller areas while most research has been conducted by non-governmental organisations and individuals without clear objectives and related indicators. Systematic collection and recording of marine litter data in the Republic of Croatia does not exist at the moment, nor any type of strategic document/legal act which refers exclusively to the issue of such litter. Therefore, there is a strong need to strengthen the efforts in achieving the goals which will develop comparable and consistent standards of monitoring and the starting line, and coordinate protocols between bordering countries. Monitoring the condition of marine litter is suitable for grading and monitoring good condition of the environment through the following criteria and indicators:

##### Properties of litter in marine and coastal areas (10.1.)

- Trends in the amounts of waste and the consequences of its degradation when it is stranded or discarded on the coast, together with analysis of its composition, origin, spatial distribution, and, if possible, source (10.1.1.)
- Trends in the amounts of waste on the sea surface, in a water column and on the seabed, together with analysis of its composition, origin, spatial distribution, and, if possible, source (10.1.2.)
- Trends in the amounts, distribution and, if possible, composition of microplastics (10.1.3.)

##### Impacts of litter on marine organisms (10.2.)

- Trends in the amount and composition of ingested litter (analysis of stomach contents (10.1.2.)

#### 1.5. Parameters selected for measuring

- Amount and composition of large waste stranded on the shore,
- Amount and composition of large waste at the sea surface and on the seabed,
- Amount, distribution and composition of microplastics on beaches and at the sea surface,
- Amount and composition of ingested sea litter.

Measurement parameters depend on the type of litter intended for monitoring. The research should include assessment of the amount and composition of individual indicators, origin assessment, assessment of yearly dynamics and mechanisms of distribution and surface of the area of influence.



## **1.6. Methodology of sampling, measuring and laboratory analysis of samples**

According to the recommendations of the European Commission it is necessary to follow the listed Guidelines when assessing and choosing methodology of sampling and sample analysis. Methodology of field work depends on the type of litter being observed and is based on visual examination, photo documentation and analysis of number, composition, mass and origin of samples. The selected methodology of sampling, measuring and laboratory analysis of data depends on the observed indicator, i.e. to which litter type does it belong. Specific methodology should follow the methods of monitoring and analysis described in: Galgani et al. (2013): Guidance on Monitoring of Marine Litter in European Seas. MSFD Technical Subgroup on Marine Litter (TSG-ML) European Commission, OSPAR (2010): Guidelines for Monitoring Marine Litter on the Beaches in the OSPAR Maritime area, NOAA (2013): Marine Debris Monitoring and Assessment: Recommendations for Monitoring Debris Trends in the Marine Environment, while considering the UNEP/MAP MEDPOL (2014) draft: Monitoring Guidance Document on Ecological Objective 10: Marine Litter, whose applicability on the coast under the sovereignty of the Republic of Croatia has been tested in the field through the project DeFishGear (Vlachogianni, 2015). Depending on the possibilities, while conducting monitoring of marine litter it is desirable to connect with monitorings of other GEC descriptors and other existing monitorings in order to minimize the expenses of monitoring implementation.

## **1.7. Data processing methodology**

Data processing methodology and its subsequent reporting is in most cases specific to a particular type of litter being monitored. Analysis of primary data and their subsequent interpretation refers to the occurrence and analysis of composition and origin, about the progress towards GEC goals and about the impact of implemented measures and actions. According to MSFD/ODMS, data processing and subsequent reporting are still in the “under consideration” phase, both at the European Union and regional level. It is necessary to conduct data analysis on different spatial scales: national, subregional, regional as well as european, with the data being comparable to keep their later interpretation simple. Responsibility for data quality should be given to a regional/national coordinator who will oversee the local network. By implementing this, a high level of consistency is secured in individual regions as well as formation of hierarchy of checking the quality of data collection. It is necessary to conduct the process of data processing and reporting by following the guidelines of DIKE working group (Data, Information and Knowledge Exchange). Special attention should be given to the role of Regional Sea Convention - Barcelona Convention, together with the implementing guidelines for data storage and quality assurance/quality control (QA/QC) for the selected monitoring protocols.