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For a Litter-Free Adriatic and Ionian Coast and Sea

Methodology for Monitoring
Marine Litter on the Seafloor (continental shelf)
Bottom trawl surveys

Photo ©Tiziana Chieruzzi

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The IPA-Adriatic funded DeFishGear project aims to facilitate efforts for integrated planning to reduce the environmental impacts of litter-generating activities and ensure the sustainable management of the marine and coastal environment of the Adriatic-Ionian macroregion. The DeFishGear activities are implemented by a multi-disciplinary team comprising academia, research institutes, national and local authorities and NGOs from all seven countries of the Adriatic and Ionian Seas, reinforcing and strengthening cooperation and fostering joint and harmonized actions towards a litter-free Adriatic and Ionian Coast and Sea.

Methodology for Monitoring sea-floor Litter with bottom trawls

1.   Introduction

The following methodology has been prepared based on the EU MSFD TG10 "Guidance on Monitoring of Marine Litter in European Seas (2013)", the NOOA "Marine Debris Monitoring and Assessment: Recommendations for Monitoring Debris Trends in the Marine Environment (2013) and the "MEDITS International bottom trawl survey in the Mediterranean, Instructional Manual", taking into consideration the draft "UNEP/MAP MEDPOL Monitoring Guidance Document on Ecological Objective 10: Marine Litter (2014)".

2.   Introduction

The bottom trawling method is considered to be the most suitable for large scale evaluation and monitoring of benthic debris. Nevertheless there are some sampling restrictions in rocky areas and in soft sediments and the method may underestimate the quantities of litter present.

As pointed out in the 2013 report of the MSFD Technical Subgroup on Marine Litter, international bottom trawl surveys, like the MEDITS survey in the Mediterranean Sea[1], provide the most suitable means for broad-scale evaluation and monitoring of sea-floor litter. In the MEDITS survey, a harmonized methodology is used and, specifically, a common gear and fishing operation and sampling scheme (GOV net, 20 mm mesh, 30-60 min tow, covering of the entire 10-800 m depth zone). Most importantly, MEDITS provides the means (though the use of acoustic equipment) for monitoring the trawl geometry and the accurate estimation of the "swept area", a parameter required for recording litter as items per km^2.

It is clarified herewith that the MEDITS protocol is followed as close as possible and emphasis is placed on the standardization of post-sampling operations (identification, categorization and enumeration of litter).

3.   Site selection

Sites should be selected to ensure that they:

- ✓ Comprise areas with uniform substrate (ideally sand/silt bottom);
- ✓ Consider areas that might accumulate litter;
- ✓ Avoid areas of risk (presence of munitions), sensitive or protected areas;
- ✓ Do not exert impacts on any endangered or protected species.

Sites should be chosen following a two-fold approach: (i) selecting sites that meet certain criteria (e.g. are close to ports, river mouths, cities, etc.); (ii) choosing randomly from a large number of sites.

4.   Survey area

With regards to the sampling area, the MEDITS survey uses a depth stratified sampling scheme with random selection of trawling sites (same positions each year) within each stratum. The sampling strata are the depth zones: 10-50, 50-100, 100-200, 200-500 and 500-800 m. The number of stations in each stratum is proportional to the surface of these strata (see table 1).

Within this methodology, the following strata are proposed to be sampled: (a) 10-50 m, (b) 50-100 m, and 100-200 m, i.e. only the continental shelf will be covered. The size of the sampling area should be defined by each surveying team on the basis of the resources available for this task. The sampling density will be at least 2-3 stations (hauls) per 1000 km^2 in each stratum (average sampling density of the MEDITS survey) and/or 2-3 stations per sampling stratum.

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[1] *The MEDITS survey fully covers the area of the DeFishGear project (GFCM Geographical Subareas 17, 18 and 20).*

Table 1. *Surface area of depth strata and corresponding number of stations in the MEDITS survey by country and GFCM Geographical subarea (GSA). GSA17: Northern Adriatic; GSA18: Southern Adriatic; GSA20: Eastern Ionian.*

GSA	Depth stratum	Area (km²)						Targeted number of hauls					
		Italy	Slovenia	Croatia	Montenegro	Albania	Greece	Italy	Slovenia	Croatia	Montenegro	Albania	Greece
GSA17	10-50 m	22000	184	7308				43	2	14			
	50-100 m	18550		14785				37		28			
	100-200 m	14950		7225				30		13			
	200-500 m	3900		2409				8		5			
	500-800 m	950						2					
GSA18	10-50 m	2582			280	568		9			2	2	
	50-100 m	3104			1100	2231		11			2	7	
	100-200 m	5778			1700	2186		20			2	6	
	200-500 m	1771			1150	1840		6			2	6	
	500-800 m	2038			770	1910		7			2	6	
GSA20	10-50 m						2916						6
	50-100 m						4365						9
	100-200 m						2536						5
	200-500 m						3158						6
	500-800 m						3848						6

## 5. Frequency and timing of surveys

The proposed survey periods are:

- ✓ Autumn: September-October
- ✓ Spring: April

Following the MEDITS protocol, the hauls should be ideally performed during daylight. The daylight period is defined as the time between 30 minutes after sunrise and 30 minutes before sunset.

6. Trawling operation

Given that surveys might be performed with otter trawl fishing fleets or research vessels which use different gear (unlike the MEDITS surveys which use GOV nets), with no acoustic equipment, etc., it is evident that handling operations and parameters (such as type of mesh, mesh size of cod end, etc.) during the surveys cannot be standardized among and between the teams performing them. Nevertheless, MEDITS survey protocol should be followed as close as possible as described below:
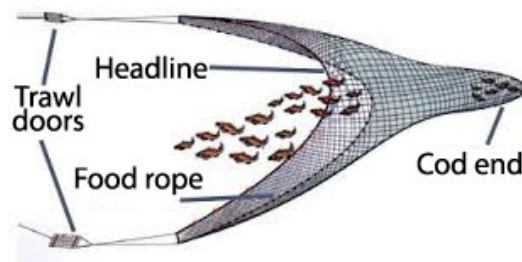
— **Haul position & orientation:** The hauls should be positioned following a stratified sampling design, including at least three strata: 20-50 m; 51-100 m; 101-200 m, wherever possible. The hauls should be made over the same position in each sampling survey. The depth variations during the haul should not exceed ± 5% relative to the initial depth. The discrepancies to this target should be recorded. As far as possible, the hauls should be rectilinear.

— **Haul speed & duration:** The vessel speed should be 3 knots during the haul. However, if the skipper indicates that a slightly different speed is appropriate for optimal gear operation (depends on net characteristics) the vessel speed can be altered accordingly. In any case, vessel speed, hauling

depth and geographical position should be continuously monitored during the haul (e.g. every 5 min). The haul duration is fixed at 30 min.

— **Haul start and end definition:** The start of the haul is defined as the moment at which the trawl geometry (vertical and horizontal) is stabilized. In the absence of electronic equipment (acoustic devices like SCANMAR, etc.) the actual start time will be indicated by the skipper. The end of the haul is defined as the moment at which warp hauling begins.

— **Gear characteristics:** Cod-end mesh size and head rope length should be recorded.

7. Size classes to be surveyed

The following size range classes will be reported for each recorded litter item:

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

8. Identification of litter

All items collected from the haul should be entered on the 'Benthic Litter Monitoring Sheet'. On the sheet, each type of item is given a unique identification number. The identification and correct categorization of litter items should be facilitated by the 'Photo Guide'.

Unknown litter or items that are not on the survey sheet should be noted in the appropriate "other item box". A short description of the item should then be included on the survey sheet. If possible, digital photos should be taken of unknown items so that they can be identified later and, if necessary, be added to the survey sheet.

9. Quantification of litter

The unit in which litter should be recorded is the number of items and it should be expressed as counts of litter items per square kilometer (litter items/km^2). The total weight of litter items per haul should be recorded, as well as the weight per each litter main category. In addition, the total weight of each haul should be recorded, as well as the weight of the commercial fish caught in it.

The estimation of litter items/km^2 requires the estimation of the "swept area". The latter is difficult to be monitored accurately during the haul because it requires the use of specialized equipment, like acoustic devices mounted on the trawl net. Such instruments might not be available during the samplings. However, the skipper, knowing by experience the geometry of the gear, can advise the surveying team on the effective mouth width and height of the net during each fishing operation.

Alternatively, the swept area can also be estimated following the method of Sparre and Venema (1998):

The trawl sweeps a path, the area of which is the length of the path times the width of the trawl, called the "swept area" or the "effective path swept". The swept area (**a)** can be estimated by:

$$a = D * h * X \qquad where\ D = V * t$$

Where:

V is the velocity of the trawl over the ground when trawling;
h is the length of the head-rope;
D is the cover of distance;
t is the time spent trawling;

X is that fraction of the head-rope length, which is equal to the width of the path swept by the trawl. The value of X varies from 0.4 to 0.66 for tropical waters and a value of X = 0.5 has been suggested as the best compromise value for the Mediterranean Sea (Sparre and Venema, 1992).
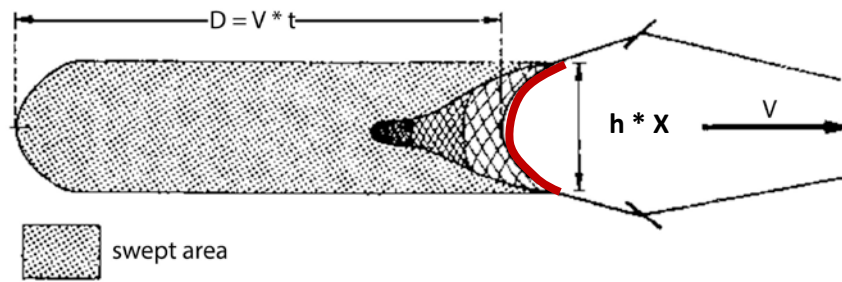
Figure 1. Swept area (source: http://www.fao.org/docrep/w5449e/w5449e0f.htm)

When exact positions of the start and the end of the haul are available the distance covered can be estimated in units of nautical miles (nm), by:

$$D = 60 * \sqrt{(Lat1 - Lat2)^2 + (Lon1 - Lon2)^2 * \cos^2(0.5 * (Lat1 + Lat2))} \ldots\ldots$$

Where:

Lat1 = latitude at start of haul (degrees)
Lat2 = latitude at end of haul (degrees)
Lon1 = longitude at start of haul (degrees)
Lon2 = longitude at end of haul (degrees)

10. Equipment/Consumables

The following items are necessary to carry out beach surveys:

- ✓ Bucket or box
- ✓ Tape measure
- ✓ Plastic bags to collect the litter
- ✓ Digital camera
- ✓ Hand-held GPS unit
- ✓ Extra batteries (ideally rechargeable batteries)
- ✓ Clipboard for the surveyor
- ✓ Digital scales for weighing litter (ideally with a 1g precision)
- ✓ Recording sheets (printed on waterproof paper)
- ✓ Pencils
- ✓ First aid kit (to include sunscreen, bug spray, drinking water).

11. References

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Monitoring Marine Litter (Macro) on the Seafloor
Data Sheet

Location name	
Location ID	
Country	
Surveyor Name	
e-mail address	
Date of survey	

VESSEL CHARACTERISTICS

Vessel name			Name of the vessel
Type of vessel			Type e.g. research, fishing, hired, regular ferry etc.
Vessel length and tonnage			Length of the vessel (metres) Gross weight of the vessel (tonnes)
Vessel engine power			Vessel engine power (kilowatt)

HAUL DETAILS

Latitude/longitude start			Recorded as nnn.nnnnn degrees at the start of the sample unit
Latitude/longitude end			Recorded as nnn.nnnnn degrees at the end of the sample unit
Coordinates system			Datum and coordinate system employed
Vessel speed			Average vessel speed in knots
Start time/end time			Time over which the survey (haul) took place
Mouth horizontal/vertical opening			Record the trawl mouth horizontal and vertical opening (mm)
Haul position/depth			Record the average haul position
Cod end mesh size			Record mesh size (mm)
Cod end type			Type of cod end e.g. diamond mesh, square mesh
Head rope length			Record the length of the head rope (m)

ENVIRONMENTAL PARAMETERS - OBSERVATION DETAILS

Wind speed		Recorded in (Beaufort)
Wind	☐ N ☐ E ☐ S ☐ W	Tick more than one boxes e.g. for SE wind
Sea state		Expressed in accordance with the Douglas Sea Scale (0-9)

NOTES

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SITE CHARACTERISTICS			
Nearest river name			*Name of nearest river*
Nearest river distance			*Distance to the nearest natural input (river or stream) (kilometers)*
Nearest river position	☐N ☐E ☐S ☐W		*Position of river mouth in relation to survey area*
Nearest major fishery			*Name of the nearest major fishery (named by type)*
Nearest major fishery distance			*Distance to the nearest major fishery (kilometers)*
Nearest major fishery position	☐N ☐E ☐S ☐W		*Position of the nearest major fishery in relation to survey area*
Nearest town			*Name of nearest town*
Nearest town distance			*Distance to the nearest town (kilometers)*
Nearest town position	☐N ☐E ☐S ☐W		*Position of the nearest town in relation to survey area*
Population size of this town			*No of inhabitants*
Additional features of the town	☐ Residential ☐ Tourist ☐ Residential & tourist	☐ Winter ☐ Spring ☐ Summer ☐ Autumn	*Indicate the main characteristic of the town, residential or touristic town; in case of the later indicate the high season peak*
Name of the nearest beach			*Name of the nearest beach*
Distance to nearest beach			*Distance to the closest coastline (kilometers)*
Position of the nearest coast	☐N ☐E ☐S ☐W		*Position of the closest coastline in relation to survey area*
Nearest shipping lane distance			*Distance to the nearest shipping lane (kilometers)*
Estimated traffic density			*Recorded in number of ships/year*
Vessel type			*Indicate the type of vessels that mainly use it e.g. merchant ships, etc.*
Position of the shipping lane	☐N ☐E ☐S ☐W		*Position of shipping lane in relation to survey area*
Name of the nearest harbor			*Name of nearest harbor*
Harbor position	☐N ☐E ☐S ☐W		*Position of the nearest harbor in relation to survey area*
Type of harbor			*Based on the types of vessels visiting the harbor*
Size of harbor			*Record the number of ships that reach the harbor per year*
Nearest discharge of waste water distance			
Position of nearest discharge point	☐N ☐E ☐S ☐W		*Position of nearest discharge points in relation to survey area*
NOTES			
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TYPE OF MATERIAL							SIZE
ARTIFICIAL POLYMER MATERIALS	RUBBER	CLOTH/ TEXTILE	PAPER/ CARD-BOARD	PROCESSED/ WORKED WOOD	METAL	GLASS/ CERAMICS	

G2	G6	G10	G18	G20	G27	G39	G45	G48	G51	G55	G59	G61	G66	G67	G93	G95	G96	G98	G99	G124	G125	G127	G128	G132	G133	G134	G136	G137	G141	G142	G145	G146	G148	G158	G160	G170	G173	G175	G176	G180	G182	G185	G187	G193	G194	G196	G197	G200	G201	G208	G209	G210	CLASSES
Bags	Bottles	Food containers inc. fast food containers	Crates and containers / baskets	Plastic cups and lids	Cigarette butts and filters	Gloves	Mussel nets / Oyester nets	Synthetic rope	Fishing net	Fishing line (entagled)	Fishing line / monofilament (angling)	Other fishing related	Strapping bands	Sheets, indus. packaging, plastic sheeting	Cable ties	Cotton bud sticks	Sanitary towels/panty liners/backing strips	Diapers/nappies	Syringes/needles	Other plastic/polystyrene items (identifiable)	Balloons and balloon sticks	Rubber boots	Tyres and belts	Bobbins (fishing)	Condoms (inc.pac)aging)	Other rubber pieces	Shoes	Clothing/rags (clothing, hats, towels)	Carpet & Furnishing	Rope, string and nets	Others textiles (inc.rags)	Paper/cardboard	Cardboard (boxes & fragments)	Other paper items	Pallets	Wood (processed)	Other (specify)	Cans (beverage)	Cans (food)	Appliances (refrigerators, washers, etc.)	Fishing related (weights, hooks, sinkers, lures	Middle size containers	Drums, e.g. oil	Car parts / batteries	Cables	Large metallic objects	Other (metal)	Bottles (incl. pieces)	Jars (incl. pieces)	Glass or ceramic fragments (> 2.5 cm)	Large glass objects (specify)	Other glass items	G.< 5cm*5cm = 25cm^2 H.< 10cm*10cm = 100cm^2 I. < 20cm*20cm = 400cm^2 J. < 50cm*50cm = 2500cm^2 K. < 100cm-100cm = 10000cm^2 = 1m^2 L. > 100cm-100cm = 10000cm^2 = 1m^2

HAUL RESULTS		
Total weight of litter in the haul		*Record litter weight in Kg*
Total weight of artificial polymer materials		*Record litter weight in Kg*
Total No of items of artificial polymer materials		*Record number of items*
Total weight of rubber		*Record litter weight in Kg*
Total No of items of rubber		*Record number of items*
Total weight of cloth/textile		*Record litter weight in Kg*
Total No of items of cloth/textile		*Record number of items*
Total weight of paper/cardboard		*Record litter weight in Kg*
Total No of items of paper/cardboard		*Record number of items*
Total weight of processed/worked wood		*Record litter weight in Kg*
Total No of items of processed/worked wood		*Record number of items*
Total weight of metal		*Record litter weight in Kg*
Total No of items of metal		*Record number of items*
Total weight of glass/ceramics		*Record litter weight in Kg*
Total No of items of glass/ceramics		*Record number of items*