

PLASTIC POLLUTION ON THE TUSCAN COAST: ENVIRONMENTAL MEASURES MUNICIPALITIES CAN PUT IN PLACE TO REDUCE IT

Tosca Ballerini, Yuri Galletti, Daniela Tacconi

Abstract: Pollution by plastics and other chemical pollutants is outside of safe operating space of the planetary boundary for humanity. Scientific evidence shows that to address plastic pollution, it is urgently needed to deploy upstream interventions to reduce primary plastic production. In parallel to actions at the international and national level, municipalities can significantly limit single-use plastic pollution on their territory through the development of integrated strategies. Here, we show results of beach litter monitoring on three municipalities of the Tuscan coast, Tyrrhenian Sea, Italy. We identified environmental measures put in place by the municipalities to address single-use plastic (SUP) items and highlight further possible environmental measures to reduce plastic pollution at the local level.

Keywords: citizen science, environmental regulations, monitoring, plastic pollution, single-use plastic

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Introduction

Pollution by plastics and other chemical pollutants is already outside of safe operating space of the planetary boundary for humanity [19]. The accumulation of plastic waste and associated toxic chemicals in the environment follows the increase of plastic production, which is projected to triple by 2060 under *business-as-usual* scenarios [15]. To address plastic pollution, it is urgently needed to reduce the production of primary plastic polymers [4]. In response to this crisis, the Fifth United Nations Environment Assembly (UNEA-5.2) adopted a resolution for a mandate to develop an internationally legally binding agreement by 2024 to end plastic pollution both in the marine and in the terrestrial environment considering the whole life cycle of plastics.

The European Plastic Strategy (COM/2018/028final) has set an aspirational reduction target of 30 % for marine litter and the Single-Use Plastics Directive (SUPD, 2019/904/EU) set out a goal for EU Member States to reduce the impact of certain single-use plastic products in the environment, by reducing or banning their use. The EU Marine Strategy Framework Directive (MSFD, 2008/56/EC) has the goal reach the Good Environmental Status (GES) of EU marine waters.

Beach litter is one of the indicators of the MSFD (D10C1.1) “*The composition, amount and spatial distribution of litter on the coastline [...] are at levels that do not cause harm to the coastal and marine environment*”. It is easily detectable [12], correlates with the amount of marine litter, and has been successfully monitored worldwide through citizen science [26;30]. Data collected through citizen science can assist local decision-making [14]. Indeed, in parallel to actions at the international and national levels, municipalities can significantly limit plastic pollution on their territory through the development of integrated strategies [3; 32].

Here, we present results of beach litter monitoring, in three municipalities of the Tuscan coast, Tyrrhenian Sea, Italy, carried out between autumn 2022 and summer 2023 with the help of citizen scientists. We also present an analysis of the environmental measures to address pollution by single-use plastics (SUP) deployed by the three municipalities and suggest further possible actions to reduce this pollution at the local level.

Materials and Methods

Monitoring of beach litter items

Litter items were monitored on three beaches on the Tuscan coast, Italy, between November 2022 and July 2023 (Figure 1; Table 1). The sites are representative of different types of natural environment and all beaches are legally accessible by the public. At each site, a sampling unit was identified as a fixed section of the beach from the water’s edge to the back of the beach of 100 m length. During the surveys, litter items were detected by visual observations and were removed (no digging to release litter buried in the sand, but litter items half under the sand were retrieved). Litter items were counted and categorized according to the *Joint List of Litter Items* developed by the MSFD Technical Group on Marine

Litter distinguishing 183 item categories grouped by 9 material types [9]. Data were reported as number of litter items / 100 m survey and were aggregated at different temporal / spatial scales using the median, the preferred calculation method to aggregate data to assess EU marine beach litter baselines [13]. The top 10 most abundant litter items for each site and the top 20 litter items across all surveys were identified by lumping together the items over the different measurements and presented as fraction of the total litter items. Overall, 55 volunteers were trained and took part in the surveys. The authors of the paper supervised the final classification of beach litter items, transcribed the field work data in an electronic spreadsheet and compiled the associated meta-data.

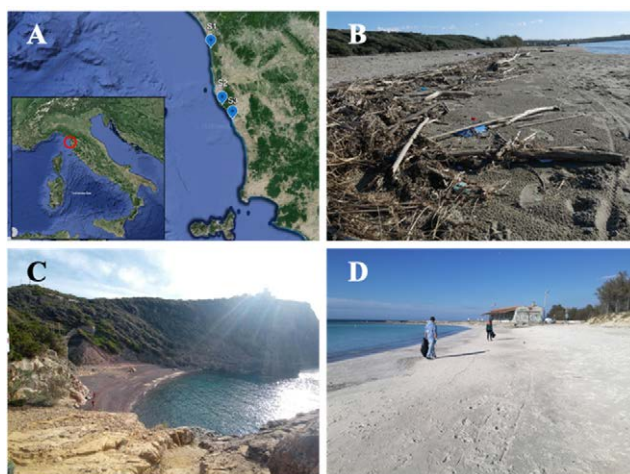


Figure 1 – Map of the Tuscan coast (A) and the three study sites: S1 – Bocca di Serchio (B), S2 – Cala del Leone (C), Lillatro (D).

Environmental measures to address SUP items by municipalities

Three in-presence and two online meetings were carried out with the environmental councilors of the three municipalities to illustrate the results of the beach monitoring and discuss the environmental measures that municipalities have already deployed or can put in place in the future to address plastic pollution. In April 2024 a questionnaire was provided to the councilors asking them which environmental measures had been put in place in their municipality. Questions were taken from a report of guidelines for municipalities on how to reduce plastic waste from SUP single-use items developed by the regional branch Emilia Romagna of the National Association of Italian Municipalities (ANCI Emilia Romagna) [2]. A first set of questions regarded “Measures to reduce single-use products in different policy areas” grouped under different areas of intervention. A second set of questions “Behaviors to be promoted and related measures” included 8 behaviors with associated target flows, target scopes, and the main measures that the municipalities can put in place. Councilors were asked to evaluate each

environmental measure on the base of a Plus, Minus, Interesting (PMI) analysis [23] listing, respectively, all the advantages (PLUS), disadvantages (MINUS), and anything that needs future investigation (INTERESTING). On May 2024, a workshop on the role of municipalities on the environmental transition was carried out and the guidelines for municipalities on how to reduce waste from single-use items were presented in details by their lead author [2]. A SWOT (strengths, weaknesses, opportunities, and threats) analysis on the implementation of environmental measures by municipalities to reduce plastic pollution was then carried out.

Table 1 – Abundance of litter items on the three survey sites along the Tuscan coast.

Site	Location	Description of sampling site	Date	Abundance (items / 100 m survey)
S1	Bocca di Serchio (Marina di Vecchiano)	Sandy beach close to the river mouth of the Serchio River, inside the park of Migliarino San Rossore Massaciuccoli.	05/11/22	1266
			26/03/23	1266
			05/06/23	1121
S2	Cala del Leone (Livorno)	Small bay with pebbles. Free beach, not equipped.	01/11/22	438
			02/04/23	1191
			23/06/23	1471
S3	Lillatro (Rosignano)	Sandy beach with an anthropized dune system, close to a beach resort. Partially equipped in the summer period.	13/11/22	1526
			25/02/23	2354
			14/07/23	604

Results

Abundance and types of beach litter items

A total of 11 237 litter items were collected and categorized for a median litter abundance of 1266 items / 100 m (Table 1, Figure 2). A total 126 item categories were found and of these 55.13 % were items of undefined use. Litter items made of artificial polymers represented the majority of items in total (88.39 %: Figure 2) and at the three sites (S1: 96.47 %; S2: 78.45 %; S3: 88.67 %; Figure 3D). Litter items in paper and cardboard and litter items in metal corresponded, respectively, to 3.42 % and 3.14 % of total litter items. Other materials were represented by less than 2 % (Figure 2). Litter items featuring in the top 10 across all surveys correspond to 79.44 % of total litter items, while litter items featuring in the top 20 across all surveys correspond to 89.04 % of total litter items and six of them are single-use plastic (SUP) products according to the SUPD (14) (Figure 2). They are: cigarette butts (22.69 %), plastic drink bottles (4.38 %, all sizes together), plastic caps/lids drinks (2.89 %), plastic cotton bud sticks (2.79%), plastic crisps packets/sweets wrappers (1.61 %) (Figure 2). Overall, SUP items correspond to 36.96 % of the total litter items.

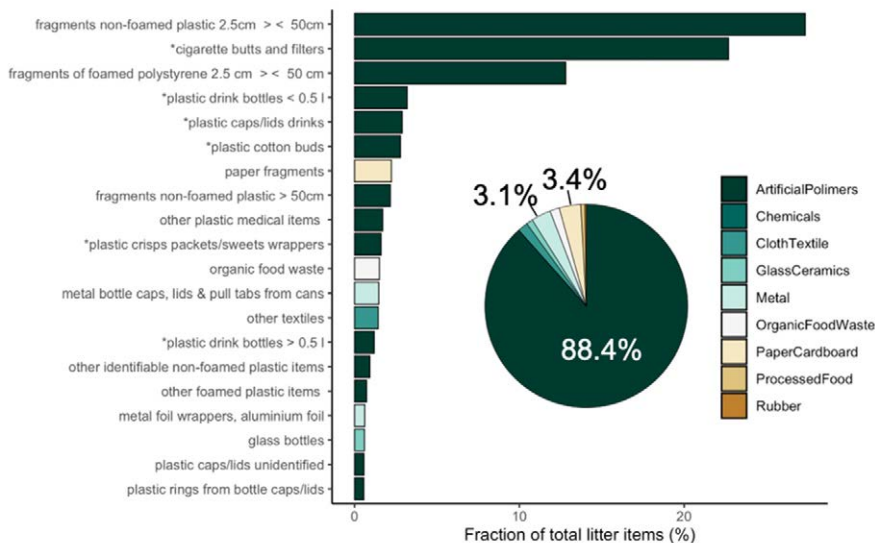


Figure 2 – Top litter items and materials found on Tuscan beaches between 2022 - 2023. Top 20 litter items are shown as fraction of the total. Percentages <2% are not shown. The symbol “*” indicates SUP items.

The highest abundance of litter items was found at S3 (range: 604 ÷ 2354 litter items / 100 m survey), followed by S1 (range: 1121 ÷ 1266 litter items / 100 m survey) and S2 (range: 438– 1471 litter items / 100 m survey) (Table 1). At S1, the top 10 litter items over the three surveys (85.98 % of the total) were all artificial polymers (Figure 3A). SUP items were found at each sampling occasion, and plastic cotton bud sticks were the most abundant (310 items during the first survey, and 59 items at the third survey). At S2, the top 10 litter items over the three surveys correspond to 79.71 % of total items (Figure 3B). SUP items were found at all sampling occasions, and the most abundant were cigarette butts with filters (35, 0, and 571 items respectively during the first, second and third surveys), plastic drink bottles ≤ 0.5 l (2, 3 and 300 items, respectively, during the first, second and third surveys), plastic drink bottles > 0.5 l (58, 34, and 16 items respectively at the first, second, and third survey). During the third survey, 49 glass bottles were found. At S3 the top 10 litter items over the three surveys corresponded to 89.72 % of total (Figure 3C). SUP items were found in each sampling occasions, and cigarette butts with filters were the most abundant (1040, 430, and 317 items respectively during the first, second, and third survey). Litter items collected in the watershed of Serchio River and discharged at its river mouth are probably the most abundant source of litter items at S1, while at S2 and S3 the main source of litter items is likely related to coastal-based tourism and recreation at S2 and S3).

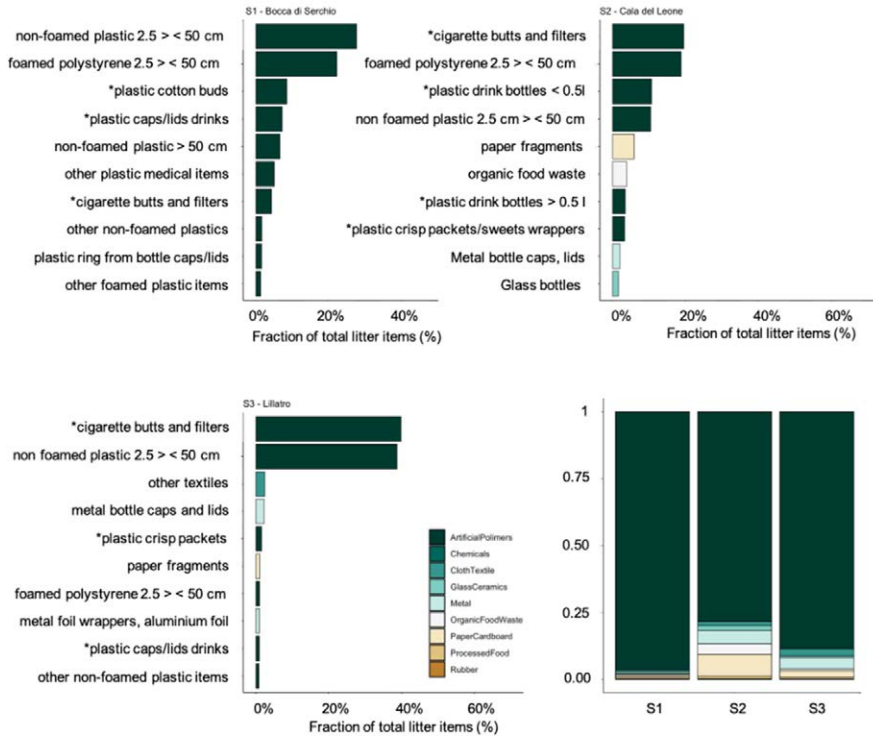


Figure 3 – Top 10 litter items and materials at S1 (A), S2 (B), S3 (C) and litter composition (D) on the three sites on Tuscan beaches between 2022 - 2023. Top 10 litter items are shown as fraction of the total. Percentages <2 % are not shown. The symbol “*” indicates SUP items.

Environmental measures by municipalities

Results of the questionnaire (Table 2) show that for what concerns the “Measures to reduce single-use products in different policy areas”, only 13 out of 45 possible measures listed in [2] have been put in place by at least one municipality in 6 out of 10 policy areas, while for what concerns the “Behaviors to be promoted and related measures”, out of 28 possible measures only 7 have been implemented by at least 1 municipality to promote 5 out of 7 behaviors listed in [2]. As part of actions aimed at reducing plastic pollution and promoting sustainability, the municipality of Livorno put in place Ordinance No.256 of 26/07/2019, Ordinance No. 260 of 30/07/2019, and Ordinance No. 7 of 14/01/2020 that include provisions to prohibit the marketing and use of “non-biodegradable” disposable containers and tableware on beaches and at fairs and festivals, in parks, and at sporting events, respectively. The municipality of Rosignano Marittimo put in place Ordinance No. 319 of 24/07/2019 that bans single-use plastic objects on beaches. It also approved the “Regulation governing the conduct of temporary commercial initiatives (markets) and other particular concessions for temporary sales on public areas - updated 16/09/2021” that includes the obligation to use

disposable material (plates, glasses, cutlery, etc.) exclusively of the “biodegradable and/or compostable type” and “Regulation for the environmental management of food and drinks during temporary initiatives and festivals - updated 16/09/2021”, which includes the ban on single-use plastic and glass bottles, obligation to use reusable drink containers or tap water; the ban on the distribution of packaged single-serving products such as cakes, yoghurt, desserts; the obligation to use reusable tableware (plates, cutlery and glasses) and/or “biodegradable thermoplastic materials”.

Table 2 – Environmental measures put in place by at least one municipality.

Policy areas
<i>Municipal offices:</i> Removal of PET water bottles from meetings and replacement with reusable bottles or tap water; Installation of water fountains.
<i>Events, conferences, public events organized at municipal facilities:</i> Water fountains.
<i>Shows, festivals and events on public land:</i> Water fountains; Washable crockery and dishwasher kit rental service
<i>Schools and universities including school catering service:</i> Training and awareness-raising; Invitation to use own water canteen/bottle; Installation water fountains; Promotion of mid-morning fruit and backed goods as a substitute for packaged products.
<i>Retail activities (small and large-scale distribution):</i> Communication/awareness-raising, measures to promote reduction of single-use products (but allowing “biodegradable plastics”)
<i>Citizens and visitors/ tourists:</i> Communication/awareness-raising (cigarette butts and litter); Reusable tableware rental service for small events.
Behaviors to be promoted
<i>Use of reusable shopping bags:</i> Awareness-raising activities
<i>Use of reusable crockery and glasses at home, private parties:</i> Reusable crockery and glassware rental service
<i>Use of reusable crockery and glasses for events / festivals:</i> Awareness raising
<i>Use of reusable glasses and tableware in schools:</i> Awareness raising; water fountains; distribution of reusable water bottles
<i>Use of tap and reusable tableware:</i> Water fountains

Discussions carried out during the May 2024 workshop allowed to identify some lack of specific-in house expertise, in particular regarding “biodegradable plastics” and at the request of councilors, scientific information was shared about their characteristics and their environmental impacts. The councilors highlighted the difficulties in ensuring citizens’ compliance to existing regulations in face of lack of resources. For example, Rosignano Marittimo had approved the “Municipal Council Resolution No. 273 of 19/09/2019 - Approval of guidelines concerning the protection of public health, aimed at banning smoking and littering of smoking products on municipal beaches” but the resolution was never transformed in administrative act because of difficulties to enforce it. The environmental councilor of Marina di Vecchiano highlighted the lack of resources in terms of technical personnel and expertise in small municipalities. Councilors also highlighted the challenges for an effective communication with citizens. There was common

agreement on the opportunity to promote collaboration with local stakeholders (universities, research centers, NGOs) and promote future citizen science projects to enhance citizens' education and awareness. These considerations have been included in the SWOT analysis (Table 3).

Table 3 – SWOT (strengths, weaknesses, opportunities, and threats) analysis for the implementation of environmental measures by municipalities to reduce plastic pollution.

Strengths	Weaknesses
Direct regulatory power to implement local regulation and policies that can lead to significant changes; Setting plastic free and single-use free public procurement policies, targeted supplier requirements and contracts; High level of community and associations involvement and participation; Collaboration with local universities and research centers; Engagement in citizen science projects and citizens' education and awareness; Experience in EU project (Livorno as cascade city – Horizon 2020).	Lack of specific in-house expertise able to define effective strategies; Lack of resources; Lack of a structured system for coordinating stakeholder participation (working groups); Difficulties in ensuring citizens' compliance the existing regulations; Challenges to effective communication with citizens.
Opportunities	Threats
Join forces among municipalities to build critical mass and create greater synergies in reducing the use of single-use products; Municipalities as governance network actors through the involvement of ANCI Toscana; Establishment of living labs for the development and monitoring of pilot actions, which will serve as models for other coastal cities; Regional, national and European funds; New opportunities and engagement of young people; Lower environmental and social costs associated with waste generation.	Economic system still oriented towards use-and-throw-away rather than reuse and circular and regenerative models; Italian regulatory framework in partial contrast to EU directives and actions to reduce single-use products; Danger of “regrettable substitutions” (the change from a known hazardous to not-yet-known hazardous substance) [10]; Conflicts with specific categories of stakeholders could compromise the social contract with some of them delaying policy implementation.

Discussion

Abundance of SUP items higher than the EU marine litter threshold

To achieve or maintain a Good Environmental Status (GES), the MSFD Technical Group on Marine Litter set the threshold value for beach litter at 20 litter items /100 m beach length, considered as a value able to reduce harm from beach litter to a sufficiently precautionary level [28]. This value was largely surpassed in all surveys in this study, in which 88.39 % of the litter items were artificial polymers, and 36.96 % of all litter items were SUP items for which reduction or banning prescription exist according to the SUPD. Despite difficulties in comparing abundance of litter items with other locations due to inhomogeneity in the sampling methods [5], the median beach litter density reported here (1266 items / 100 m) is

higher than in precedent surveys along the Tuscan coast (603 items / 100 m in the period 2020 – 2021 [8]), the Tyrrhenian Sea (491 items/100 m between 2015 - 2018; [11]), and at the level of the Western Mediterranean Sea (196 and 255 items / 100 m survey in 2015 and 2016, respectively Hanke et al.). In this study we detected a higher contribution of artificial polymers over total litter items in comparison to the Italian coastline in the period 2015 – 2018 (74 % [11]) and a value comparable to European beaches between 2015-2021 [85 %; 26].

Temporal series on macrolitter abundance are important to evaluate through time the effectiveness of the implementation of existing environmental regulations. Beach litter density estimates gathered in this study are the firsts available for the three beaches and additional surveys in the future will allow to gather baseline values estimates with adequate precision to be able to detect changes of macrolitter abundance in time [22]. For the assessment of accumulation and loading rates during regularly repeated surveys no clean ups should occur on the sampled site between two monitoring surveys [12]. However, partial clean ups by beach users occurred between the second and the third survey at S2 and S3, thus the data reported here represent a low-end estimate of accumulation and loading rates on the Tuscan coast over the study period.

The SUPD has been transposed in the Italian legislation with the Legislative Decree n. 196 of 8 November 2021 that came into force on 14 January 2022, respectively 10 and 18 months before the first (November 2022) and last survey (July 2023) of this study. The most abundant SUP items found on this study (cigarette butts, drink bottles and associated caps/lids drinks, cotton bud sticks) were also among the most common litter items found on a large-scale monitoring though citizen engagement carried out on Italian beaches on May 2023 [16].

Cigarette butts

Cigarette butts and their chemical components are toxic to invertebrate and vertebrate marine organisms [24]. Since the 1980s, they have consistently been the largest single type of litter by count worldwide [2017]. They represented 20.9 % of litter on European beaches between 2015-2021 [26] and 22.69 % in this study. The resolution from smoke-free beaches by the municipality of Rosignano Marittimo, where the highest abundance was found in this study, never came into force because of anticipated difficulties in its implementation. However, smoke-free beaches exist in the USA, Australia, Canada, and Spain [27]. In Italy, the first smoke-free beach was introduced on the coast of Bibione in 2014 [6] and smoke-free beaches have now been created in more than 15 municipalities [29].

Cigarette butts are included in Part E of the Annex of the SUPD (Section III "Other single-use plastic products referred to in Art. 8(3) on extended producer responsibility") that requires Member States to ensure that producers cover at least the costs of awareness-raising measures, removal of waste from these dispersed products and the subsequent transport and treatment, and data collection and reporting. The majority of EU Member States copied and pasted this list of costs in transposing the SUPD in their national laws, but the Legislative Decree n. 196 of 8 November 2021 differs for the inclusion of a precision indicating that the costs are to be established in proportion to the weight of the plastic component in relation

to that of the product [25]. The Decree also says that “*In order to make consumers aware of the harmful environmental consequences of abandoning cigarette butts, manufacturers, in cooperation with the Ministry for the Environment, Land and Sea, implement information campaigns*”. This provision is in breach of Article 5.3 of the WHO Framework Convention on Tobacco Control (to which the EU and each Member States are parties) who recognize a fundamental and irreconcilable conflict of interest between the tobacco industry and public health and environment, and according to which manufacturers should not take part in organizing awareness-raising measures [25].

To promote the application of the extend producer responsibility, reduce littering of cigarette butts and associated pollution, municipalities could promote the development of deposit return systems (DRS) similar to those for single-use drink containers (see below) in which cigarettes could be sold with a “butt deposit” to be refunded when the butts are returned to the vender or to a hazardous waste disposal facility [18].

Drinks bottles and caps/ lids

The SUPD prescribes Member States to achieve selective collection rates of PET bottles of 75 % by 2025 and 90 % by 2029, either by establishing DRS or through separate collection targets for relevant extended producer responsibility schemes (Art. 9 “Separate collection”). A DRS place a small deposit on beverage purchases, which is refunded when the empty container is returned for recycling (DRS for recycling) or for reuse (DRS for reuse). In well-designed DRS, producers have the operational and financial responsibility of the system and fines apply if collection targets are not met. The new Packaging and Packaging Waste Regulation (PPWR), expected to entry into force in the last quarter of 2024, prescribes mandatory DRS for recycling by 2029 for plastic bottles and metal cans if a selective collection rate of 90 % is not achieved. Currently, DRS systems for recycling are in place in 16 countries in Europe with an average collection rate for PET bottles > 94 % compared to 47 % for European countries without a DRS [21].

In Italy, the introduction of a DRS for recycling would results in an increase of the separate collection rate from current 73.4 % to 95.3 % for PET bottles, from 89.6 % to 96.0 % for metal cans, and from 80.6 % to 95.8 % for glass bottles [7]. The association Comuni Virtuosi promoted a national campaign - sustained by major Italian NGOs, the Italian Society of Ecology (SITE) and several municipalities - to ask the Italian government to develop a DRS for recycling that includes plastic drink bottles, metal cans, and glass bottles [1]. While DRS systems need to be implemented at the national level, municipalities can help the promotion of reusable containers [3], as done by Rosignano Marittimo that banned single-use drink containers and promoted the use of reusable drink containers at events and festivals. The ban could be extended to other situations and to other single-use packaging.

Plastic cotton buds

Cotton buds are often flushed down toilets instead of being put in the bin and due to their size and shape end up in the marine environment via overflow events when wastewater is released with little treatment and through some treatment tanks

due to the difficulty in identifying and retaining small litter items [11]. Together with plates, cutlery, straws and balloon sticks, they are listed on Part B of the SUPD's Annex ("Single-use plastic products covered by Article 5 on restrictions on placing on the market"). Since 3 July 2023 all these products are banned on EU Member States, but they are still available for sale in Italy. Cotton buds have first been regulated in Italy by Law n. 205 of 27 December 2017 which required mandatory labeling about correct disposal and banned from January 1st 2019 all cotton bud sticks made of plastic material not conform with UNI EN 13432:2002, the Italian standard corresponding to the European EN 13432:2000 standard for compostability. An evaluation of effectiveness of Law n. 205 carried out on the Tyrrhenian coast from winter 2019 to winter 2020 showed that it did not lead to a reduction in the amount of cotton buds entering the marine ecosystem, with cotton buds still being the most abundant litter item (42.3% of total litter items [20]).

For what concerns the other SUP items listed in Part B of the SUPD's Annex, the perimeter of application of Legislative Decree n. 196 of 8 November 2021 allows them to be placed on the market if made of plastics that comply with the UNI EN 13432:2002 standard, thus in contradiction with the SUPD which applies to all artificial polymers. This is one of the reasons at the base of the decision of the European Commission to open an infringement procedure on 23/05/2024 by sending a letter of formal notice to Italy (INFR(2024)2053) in which it commented that "*Italy has failed to transpose, or to transpose correctly, several provisions of the Single-Use Plastics Directive into national law, which affects its scope and application*".

While acknowledging that targeted applications have shown some benefits, the EU Plastics Strategy points out that "*it is important to ensure that consumers are provided with clear and correct information, and to make sure that biodegradable plastics are not put forward as a solution to littering*". As well as most other plastic biodegradation standards, the EN 13432:2000 standard relies on laboratory tests and/or relate to degradation in industrial facilities in which temperature is expected to reach 70°C [40], conditions which are not relevant when the plastics are used or disposed of in natural environments. "Biodegradable plastics" also contain toxic chemicals and while their degradation is accelerated during composting (high temperature, moisture, microorganisms), it is much lower in the soil or in the ocean, leading to the additional release of toxic chemicals, and also of micro- and nano-plastics [17].

The role of municipalities in addressing plastic pollution

Municipalities can significantly limit plastic pollution on their territory through the development of integrated strategies that include public procurement, exemplarity, territorial animation, and by banning the use of certain products on their territory [3; 32]. They can also promote business that voluntarily decide to reduce the use of single-use packaging [3], thus preventing plastic waste generation. Strategies by municipalities to reduce plastic pollution also include the promotion of the consumption of tap water; the improvement of wastewater and stormwater management infrastructure to preserve the water cycle from plastic pollution; the improvement of the collection and recycling of plastic wastes [32]. Clean ups, while not a solution to littering and plastic pollution as they act

downstream from the problem, have the advantage of making people aware and allow collecting data useful for steering local strategy [32].

As shown by the promotion of single-use tableware made of “biodegradable plastic” by two of the municipalities on the Tuscan coast, however, the lack of specific in-house expertise and the fact of being immersed in the Italian regulatory framework which is in partial contrast with the SUPD and does not take into account scientific evidence hinders the capacity of municipalities to define effective strategies and poses the risk of promoting “regrettable substitutions” [10].

Conclusions

We provided the first quantitative assessment of beach litter on three beaches of the Tuscan coast showing levels of plastic pollution among the highest at the Mediterranean level. We gained an overview of the environmental measures put in place by the three municipalities, identifying the barriers and opportunities associated with implementing circular strategies to limit plastic pollution. On one hand, municipalities have the power to significantly limit plastic pollution through the development of integrated strategies and targeted regulations (Strengths); on the other, they face a lack of resources and knowledge (Weaknesses) and find themselves in an Italian regulatory framework in partial contrast with the EU Single-Use Plastics Directive and not promoting actions to reduce single-use products (Threats). Despite the strong connection of municipalities with the territory, the weaknesses and threads that have been identified hinder the transition of cities towards circular consumption models, which promote reuse and regeneration systems over disposable ones. However, we believe that the creation of synergies free of conflicts of interests among municipalities, research institutes, local associations, and citizens can lead to tangible results to reduce plastic pollution, while helping in the acceptance of environmental regulations by citizens (Opportunities).

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Author Contributions

Conception, design of the study, and methodology (TB); training of volunteers (TB, YG, DT); investigation (TB, YG, DT); formal analysis and writing - original draft (TB); writing - review and editing (TB, YG, DT); resources and project administration (YG). The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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