SEASONAL COMPARISON OF BEACH LITTER ON MEDITERRANEAN COASTAL SITES (ALICANTE, SE SPAIN)

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ABSTRACT

Presence of beach litter was assessed during spring and summer seasons 2018, at 56 sites along the coast of Alicante Province (SE Spain). Selected sites covered "remote" (9), "rural" (10) "village" (17) and "urban" (20) bathing areas. In an area of 201,700 m^2, a total of 10,101 litter items (Avg: 0.062 items m^{-2}) was counted in spring, and 20,857 (Avg: 0.116 items m^{-2}) in summer. The most significant seasonal evolution was observed in the cigarette butt, group which increased from 4607 to 12843 units. Plastic represented the dominant material in both seasons (82.6 and 83.5% respectively). Litter items increased greatly during the summer season despite the increasing frequency of cleaning operations and were essentially related to beach users activities. Secondarily, beach litter was related to wastewater discharges and fishing activities. Beach litter management along investigated sites must be based on plans to reduce litter sources. For that, it is necessary to consider beach typology along with the seasonal influx of visitors to define the most appropriate management actions, not forgetting the implementation of environmental education, essential in schools and media.

Keywords: *Marine litter, Plastic pollution, Cigarette butts, Tourism, Beach, Costa Blanca.*

1. INTRODUCTION

Tourism is one of the most important and lucrative industries in the world (Klein et al. 2004; UNWTO, 2018) and global international tourist arrivals grew by 4.4% (1,184 million people) in 2015, by 3.9% (1,235 million people) in 2016, and by 7% (1,326 million people) in 2017 (UNWTO, 2016, 2017, 2018). A total of 267.4 million international tourist arrivals was recorded at Southern Europe in 2017 of which 81.7 million pertain to Spain (UNWTO, 2018). This region is characterized by a Mediterranean climate: mild temperatures associated with annual precipitation in winter and a hot, dry season in summer (Rana & Katerji, 2000) very attractive for the "3S" tourism. The great enhancement of summer population causes a number of problems that are difficult to manage, e.g. the increase of beach litter in bathing areas. This is a main issue since a clean beach is one of the five main priorities for beach tourists around the world (Williams, 2011; Williams et al. 2016a).

Marine litter is any persistent, manufactured or processed solid material discarded, disposed or abandoned in marine and/or coastal environments, including such materials transported into the marine environment from land through rivers, wind, etc. (Coe & Rogers, 2012; Cheshire & Adler, 2009). On the coast, litter items come from land and marine sources (Sheavly & Register, 2007; Coe & Rogers, 2012) in different proportions depending on the study area. Marine litter results from land-based (approximately 80%) and sea-based activities, in addition, most litter is composed of plastic material (Allsopp et al. 2006; Bergmann et al. 2015; Seas at Risk, 2016). Litter items are discharged directly on the beach by users, especially in the summer season, when the population increases in tourist destinations, where more than 75% of the annual waste production is generated (Galgani et al. 2013).

The problems caused by the presence of litter on coasts and beaches have been extensively and variously documented over the last few decades. These issues always have an anthropogenic origin and negatively affect different ecosystems with significant consequences: the ingestion of litter items by seabirds (Kenyon & Kridler, 1969; Pettit et al. 1981; Slip & Burton, 1991; Cadée, 2002), marine turtles (Tomás et al. 2002; Schuyler et al. 2014), fish (Romeo et al. 2015) and marine mammals (Forrester et al. 1975); wildlife entanglement by the loss of fishing gear (Jones, 1995; Walker et al. 1997); transport of non-indigenous species (Barnes, 2002; Kiessling et al. 2015; Gracia C. et al. 2018); presence of hazardous materials (Williams et al. 2000; Williams et al. 2013); and even economic status, with the loss of tourism and recreation potential (Nelson et al. 1999; Ballance et al. 2000; Krelling et al. 2017). Definitely, litter is a threat to marine life and human health, with relevant economic, social and environmental impacts.

At present, marine litter is a multi-sectoral, cultural and trans-boundary problem, so taking action to curb its rising is a social duty that involves everyone. In addition, knowledge of abundance and composition of beach litter in different zones through diverse studies is essential to the appropriate development of any management strategy.

2. THE ALICANTE PROVINCE COASTLINE

The Alicante Province coastline, also known as the "Costa Blanca", is one of the most traditional tourist destinations on the Spanish Mediterranean coast and this study covered remote, rural, village and urban bathing areas within the region. The latter category includes internationally well-known places (e.g. Benidorm) with housing essentially oriented to residential tourism (Vera-Rebollo et al. 1990), a "sun, sea and sand (3S) market" (Dodds & Kelman, 2008) with a relevant economic value (Houston, 2013). Five coastal regions of Alicante: "El Baix Segura" with approximately 43.5 km of coastal length, "El Baix Vinalopó" (27 km), "L'Alacantí" (46 km), "La Marina Baixa" (32 km) and "La Marina Alta" (70.3 km) are shown in Figure 1. To the north, in the regions of "Marina Alta" and "Marina Baixa", the mountainous landscape, with coastal cliffs, gives rise to pocket beaches composed of sand, gravel and pebbles.

The coast of the central region (l'Alacantí) is made up of cliffs and, generally, sand beaches. In the south, the coast of "Baix Vinalopó" and "Baix Segura" is composed of sand beaches, dunes and at places, small cliffs and/or rocky shores. Such features are also observed at Nueva Tabarca Island, located 3 km away from Santa Pola Cape. There, artisanal fishery and tourism activities, which attract up to 3,500 visitors/day and 300,000/yr, are attempting to be compatible with their protection status of Marine Protected Areas (Ramos, 1995). The direction of littoral transport is from NE-SW in response to wind-generated waves (Fig. 1).

3. METHODOLOGY

In this paper diverse methodologies were used to determinate litter characteristics and abundance (EA/NALG, 2000; Cheshire & Adler, 2009) and beach typology (Williams & Micallef, 2009). In addition, statistical analysis was performed to define litter patterns; Analysis of variance, non-Multidimensional Scaling, Principal Component Analysis and Cluster analysis were also applied.

3.1. Litter Quantification and Grading

Data were collected in two field surveys carried out in March and August 2018 along a standard sampling unit consisting of a 100-metre long coastal sector, i.e. 50 m apart from each side of an access point, extending from the landward beach limit to the shoreline (EA/NALG, 2000). This assessment methodology is also used by Cheshire & Adler (2009), OSPAR Commission (2010) and Opfer et al. (2012). The observer covered the entire beach surface by moving along 5 m separated transects parallel to the coastline. Each litter item was visually identified and categorized into a litter group (see Photo Guide in OSPAR Commission, 2010). The same sampling area was surveyed in summer and spring and was generally located in the central part of the beach. All coastal sites were assessed during bathing hours, approximately between 11 a.m. and 7 p.m. and cleaning operations were usually carried out early in the morning and/or in late afternoon. Locally, at few crowded beaches, manual cleaning operations are also carried out during bathing hours so, probably such beaches show at the end of the day only a slight increase in the number of litter items. Evidently, a site evaluated at the end of the day (after intensive beachgoers use) may potentially show more items than at the beginning of the day, i.e. just before the arrival of beach users and/or just after beach cleanups, this being theoretically more evident at urban beaches. Anyway, it is important to highlight that according to previous assumptions, there were probably no important differences among assessments at urban beaches because within this study they were always sampled under the same conditions, i.e. in the afternoon.

The litter grade was determined by counting the number and type of items at each coastal site according to the U.K. Environmental Authority National Aquatic Litter Group litter assessment protocol (EA/NALG, 2000, Table A.1), which has been utilized in many diverse countries, such as, Spain (Micallef et al. 2011; Williams et al. 2016b); Portugal (Quintela et al. 2012); Morocco (Khattabi et al. 2009; Maziane et al. 2018); Italy (Semeoshenkova et al. 2017); Turkey (Balas et al. 2004); Malta (Micallef & Williams, 2004); UK (Tudor & Williams, 2003, 2008; Williams et al. 2014); Colombia (Williams et al. 2016a; Rangel-Buitrago et al. 2017); Cuba (Botero et al. 2017); Brazil (Corraini et al. 2018) and India (Ganesapandian et al. 2011), among others. In this method, a total of seven categories or parameters are assessed. It is easy to apply and accurate because gives a beach rating that describes the aesthetic quality as “A” grade (Very Good), “B” (Good), “C” (Fair) and “D” (Poor). Beach litter items are classified in each grade according to their abundance. Accumulations are classified according to their number of occurrence and oil is evaluated by its presence/absence. The final grading is the worst grade for any of the above parameters, i.e. if a beach is graded “B” for all categories except one, which is “D”, the overall Grade assigned to the beach will be “D”. Since litter grading categories show great differences in the number of items (Table A.1), small differences in the number of litter items counted at different beaches because of different surveying time does not affect beach grading classification.

3.2. Beach Typology

Following to the Bathing Area Registration and Evaluation (BARE) system (see Chapter 9, Williams & Micallef, 2009), each coastal site was classified into four beach types, according to the difficulty of access, level of coastal occupation and community services:

- Remote areas are mainly defined by difficulty of access (largely by boat or on foot – a walk of 300 meters or more). They are not supported by public transport and have very limited (0–5, if any) temporary summer housing. In the Mediterranean (as in this study), restaurants and second homes may be found in the summer season, occupied by a few people who may live there permanently (Williams & Micallef, 2009).

- Rural areas are located outside the urban/village environment. It is not readily accessible by public transport and has virtually no facilities. In the Mediterranean, summer beach-related recreational facilities may be found associated with rural bathing areas. Housing in rural areas is limited (generally 0–10 but may be more depending on the size of the coast) and is of a temporary (summer months) or permanent nature but without community focal centres. They are valued by beachgoers for their quietness and natural qualities (Williams & Micallef, 2009).
- Village areas are located outside the main urban environment but supported by public transport and associated with a small, but permanent, population reflecting access to organized community services. The village environment would also include 'tourist villages', mainly utilized in summer months (Williams & Micallef, 2009).
- Urban areas serve large populations with well-established public services. In the proximity of urban areas can be found commercial activities such as fishing/boating harbours and marinas. Urban beaches are located within or adjacent to the urban area (Williams & Micallef, 2009).

3.3. Statistical Analysis

From the initial 138 litter categories, 33 new groups were chosen for statistical analysis (Table 1). Some groups were combined because of their similarity: for example, Cloth pieces (CL14*) combined three size categories: 0-2.5 cm (CL14), 2.5-50 cm (CL15) and >50 cm (CL16). Another example is the group of Fishing-related debris (FRD) that combined Fishing lures/hooks (ME07), Fishing gear (PL38), Rope (PL42), String and cord (PL43), Fishing line (PL44), Light sticks (PL47) and Floats/buoys (PL48).

Two-factor analysis of variance (ANOA) was performed with respect to season and beach typology. To investigate the relationships among coastal sites according to litter content with respect to season, multivariate analyses were performed using several methods: Non-metric multidimensional scaling (nMDS), Principal Component analysis (PCA) and Cluster analysis (CA).

4. RESULTS AND DISCUSSION

4.1. Litter Magnitudes and Composition

A total of 10,101 items in spring and 20,840 items in summer were counted at the 56 surveyed beaches (Table 1). Litter diversity (expressed in number of groups/categories) was similar for spring and summer and, by combining different litter classifications (EA/NALG, 2000; Cheshire & Adler, 2009; OSPAR Commission, 2010; Opfer et al. 2012), 120 and 129 litter categories were respectively identified. Average litter abundance during spring and summer respectively was of 0.062 items m^{-2} and 0.116 items m^{-2}. Litter content varied considerably from place to place with great changes in the composition and abundance, according to season, with the greatest abundance observed at a rural beach, i.e. "Agua Amarga" (site no. 19, Table 2) with 0.373 items m^{-2} in spring and 0.661 items m^{-2} in summer. The lowest abundance was respectively observed at a village beach, i.e. Cap Negret (0.005 items m^{-2}, site no. 39, Table 2) in spring, and at an urban beach, i.e. "Almadraba" (0.021 items m^{-2}, site no. 24, Table 2) in summer. The beach of "Agua Amarga" presents an extended rocky shore and easy access, this making it frequented by fishermen all year round. "Cap Negret" is a pebble beach, very uncomfortable to stay on for several hours or to take a swim, for these reasons most users prefer to go to the two, easily accessible, adjacent beaches. Almadraba Beach, which was nourished years ago, is composed of sand (essentially) and mud sediments and for this reason, is not very attractive to beachgoers. As the type of sediment influences the cleaning method, investigated beaches were grouped into two categories, i.e. “sand beaches”, which are mechanically cleaned, and “other beaches”, e.g. rocky shore beaches, gravel and boulder beaches, etc. (Table 2), which are manually cleaned. Probably, because of the greater efficiency of the mechanical cleaning with respect to the manual one, the average litter amount is lower on sand beaches (Fig. 2). Additionally, litter on pebble beaches tends to be buried more deeply than on sand beaches and are exhumed only when storm waves attack the beach. Care must be taken regarding litter counts on these beaches otherwise surface litter might be attributed to new inputs of litter rather than the emergence to the surface of buried litter (Williams & Tudor, 2001).

The first evaluation included Holy Week; during that period beaches are often cleaned up because they start to record a litter increase due to increased tourist pressure. In summer cleaning effort are much greater, as are the number of beach users. It is difficult to compare the effectiveness of beach cleaning operations carried out at different beaches since each municipality has its own cleaning system. Palazón et al. (2016) evaluated investments of local municipalities in beach management actions such as beach cleanness, facilities, etc. but did not record any evident relationship.

Litter densities at the Adriatic and Ionian Seas, presented average values of 0.67 items m^{-2} (Vlachogianni et al. 2018); 0.41 – 0.63 items m^{-2} at the Black Sea (Topçu et al. 2013), and 3.41 items m^{-2} at Japan and Russian beaches (Kusui & Noda, 2003). Similar average densities to those found in this paper have been observed along the Brazilian coast (0.138 items m^{-2}) as observed by Oigman-Pszczol & Creed (2007). However, densities recorded in this paper were greater than ones obtained at some other places, e.g. 0.043 items m^{-2} were recorded in the China Seas (Zhou et al. 2016), maximum values of 0.045 items m^{-2} along the Bulgarian Black Sea coastline by Simeonova & Chuturkova (2019) and zero to 0.3 items m^{-1} in Antarctica (Convey et al. 2002). Considering the great population (1.838.819 inhabitants in 2018) and the elevated number of national and international visitors at the Alicante coast, values of litter abundance are low compared to other, similar Mediterranean areas (Vlachogianni, 2019).

Although there is a lot of information about coastal litter abundance, it is difficult to compare studies carried out because of the usage of different methodologies (Anfuso et al. 2015). In fieldwork carried out by different researchers, the sampling unit can differ. Beach typology, geographic conditions, etc., even the expression of results may vary, e.g. items m^{-1} (Martinez-Ribes et al. 2007), items per beach in 100 m length (Maziane et al. 2018), items m^{-2} (Vlachogianni et al. 2018), items 100 m^2 (Oigman-Pszczol & Creed, 2007; Zhou et al. 2016), etc. Results also may be expressed by weight (e.g. kg per 100 m, gr per m^2, etc.) e.g. Madzena & Lasiak, (1997); Kusui & Noda, (2003); Maziane et al. (2018) but, where beach litter groups containing light and very numerous items (e.g. cigarette butts, film, food wrappers, paper fragments, foamed plastic, etc.) are well represented, even result interpretation can be complicated.

According to individual litter categories established by different entities, i.e. UNEP, OSPAR Commission, and NOAA (Cheshire & Adler, 2009; OSPAR Commission, 2010; Opfer et al. 2012), the Top 10 Marine Beach Litter Items in the study area have been identified for each season. These categories and codes conformed to Williams et al. (2016b):

- For spring: Cigarettes, butts & filters (PL24), Hard plastic pieces (0 – 2.5cm, PL62), Cotton bud sticks (PL23), Food wrappers (PL27), Construction material (PT01), Caps/lids (PL30), Paper fragments (0 – 2.5cm, PP10), Straws (PL18), Paper fragments (2.5 – 50cm, PP11) and Foamed plastic pieces (0 – 2.5 cm, PL68).

- For summer: Cigarettes, butts & filters (PL24), Paper fragments (2.5 – 50cm, PP11), Film plastic pieces (2.5 > < 50cm, PL66), Food wrappers (PL27), Cotton bud sticks (PL23), Hard plastic pieces (0 – 2.5cm, PL62), Hard Plastic pieces (2.5 > < 50cm, PL63), Paper fragments (0 – 2.5cm, PP10), Film Plastic pieces (0 – 2.5cm, PL65) and Caps/lids (PL30).

Many of the above listed items have also been documented in other studies as very common (e.g. UNEP, 2015; Ocean Conservancy, 2016; Surfrider Foundation, 2016; Legambiente, 2017; Vlachogianni et al. 2018; Simeonova & Chuturkova, 2019). Principal beach litter composition expressed as number of total items per group(s), are presented in Table 1. Much of these items are discarded by beach users, in particular cigarette butts, which was the most abundant item in this paper's research, as has also been observed at other bathing areas by Martinez-Ribes et al. (2007), Oigman-Pszczol & Creed (2007), Topçu et al. (2013), Williams et al. (2016b) and Kungskulniti et al. (2018). Specifically, the number of cigarette butts recorded in spring (4,607 units) tripled in summer (12,843 units). At the European scale, this seasonal trend has been recorded for the top 10 beach litter items (Addamo et al. 2017).

Litter items were composed of different materials (Fig. 4): plastic being the most represented (82.6 ÷ 83.6%), followed by paper and cardboard (5.6 ÷ 8.6%), pottery and ceramics (3.4 ÷ 1%), metal (3.2 ÷ 2.6%), cloth (2.3 ÷ 1.6%), glass (1.5 ÷ 0.7%), rubber (0.6 ÷ 0.5%), wood (0.5 ÷ 0.9%) and other materials (0.3 ÷ 0.4%). Similar percentages, especially for plastics, were found in other studies carried out on different coastal zones: from 75.3% to 83.4% at the Adriatic Sea (Peraš et al. 2017; Šilc et al. 2018), 76% on British beaches (Nelms et al. 2017), 81% on Mediterranean beaches (Munari et al. 2016; Legambiente, 2017), 83.1% on sand beaches of Chile (Thiel et al. 2013) and 83.4% on the coast of South Africa (Madzena & Lasiak, 1997). Over the past few years, at several places, e.g. the Belgian coast (Van Cauwenberghe et al. 2013) and Cape Town in Africa (Chitaka & von Blottnitz, 2019), plastics found exceeded 90% of the total debris composition.

Spring/summer differences in beach litter content for a specific material was linked to the number of beachgoers. A clear increase in pieces of Paper & Cardboard and Plastic in summer, e.g. single-use plastics and cigarette butts was observed. A small increase was seen in Wood (i.e. ice lolly sticks, chip forks, fragments, etc.) and other materials (i.e. medical waste, silica, silicone, etc., Fig. 3). In the study area, the rest of the materials recorded variations in abundance, but a decrease of their proportion with respect to the total (Fig. 3). For example, in spring, the proportion of metal was 3.24% with 325 items, while in summer it represented 2.64% with 549 metal items; a similar trend occurred with clothing that ranged from 231 to 327 items and rubber, from 64 to 100 items.

With respect to glass, despite the number of fragments and glass bottles there was little seasonal difference (147 units in spring and 144 in summer, Table 1), the difference in seasonal percentage, even low, is relevant, i.e. 1.46% and 0.69% respectively for spring and summer surveys. Contrary to the rest of materials found in summer, Pottery & Ceramics decreased in percentage (from 3.45 to 1.03%, Fig. 3) and in number of items (348 – 215 units, Table 1).

Summing up, the increase of people on the beach generally caused more paper, cardboard, plastic, cloth, wood, metal and other processed materials to be found. The quantity of Glass remained constant, probably due to non-selective clean-up operations. The fact that Pottery & Ceramics decreased was probably due to both the improvement of cleaning efforts during summer and their natural borrowing because good weather conditions observed during summer months. Concerning dangerous items, the highest numbers (specifically glass fragments), were recorded at “Cala Palmera” and “Cap de l’Horta” (sites no. 27 and 28, Table 2) with more than twenty fragments found in both seasons. These two sites are usually cleaned by hand but results seems to be not very satisfactory. Fishing Related Debris (FRD) such as hooks and fishing lines, may be dangerous to either beach users and animals (seabirds, dogs, etc.). FRD presence, which ranged from 314 items in spring to 260 in summer (Table 1), was common to all types of beaches but was especially related to rural and remote areas. Sewage Related Debris (SRD), e.g. Cotton buds and sanitary towels, were frequently observed (especially in Alicante Bay, Fig. 4) and, since they present evidences of transport, it is possible that they were related to the “Rambla de las Ovejas” and “Rambla de la Albufereta” streams that flow into the bay of Alicante, and to the Segura River in Guardamar. Examples of gross litter items, such as three car tyres and metal pieces, were found, in spring and summer surveys, at “El Racó del Corb” (no. 41, Table 2); this reflects the lack of any kind of management at remote areas, probably due to the difficulty of access.

4.2. Litter Sources and Dynamics

Some litter groups are easily related to specific activities/uses (e.g. smoking, fishing from the beach, construction, etc.) and their potential sources (land or sea-based) can be certainly recognised. But, most times, identification of source is difficult since an item can have different origins (Veiga et al. 2016); in this context, the category of “unknown/mixed sources” is common in many recent studies (Prevenios et al. 2018; Vlachogianni et al. 2018). On the Costa Blanca, litter comes mainly from land sources (>80%), especially when discarded directly onto the beach (e.g. cigarette butts and food wrappers) due to beachgoer activities. A small percentage (approximately <4%, composed of hooks, lures, fishing line, string and cord, etc.) can be linked to sea-based sources. The rest, pertain to mixed or unknown sources.

The negative impacts of river supplies (e.g. Segura river, site no. 9, Fig. 1, Table 2) and of temporary watercourses flowing onto the coast (e.g. “Rambla de las Ovejas” and “Rambla de la Albufereta”, sites no. 20 and 23, Fig. 1, Table 2) is reflected by the presence and/or great amount of specific items related to wastewater discharges (i.e. cotton bud sticks, wet wipes, tampons, etc.) or floating litter such as plastic bottles. The continuous contribution of litter to these areas has generated local pollution linked to a lot of hard plastic pieces (< 1 cm in Els Tossals Beach) that could not be counted in this study. The high pollution observed at the natural reserve of the Segura River mouth was awarded with the negative award “Bandera Negra” (Black Flag) established by EA (2018).

4.3. Beach Typology and Litter Grade

Each investigated site was assorted according to the BARE and Litter Grade classifications (Williams & Micallef, 2009; EA/NALG, 2000). Below are the results by beach typology:

a) Remote: A total of nine sites are located into this category. The greatest diversity of litter grades was observed in spring (Fig. 5): “A”: very good (1 site); “B”: good (5); “C”: fair (2) and “D”: poor (1). In spring, highest litter density was found at “Els Tossals” beach (no. 9, Litter Grade “C,” 0.130 items m^{-2}) at the mouth of the Segura River, while the lowest amount was observed at “Ambolo” (no. 49, Litter Grade “B”, 0.026 items m^{-2}) a pocket-beach composed by gravel. In summer, highest litter densities were recorded at “Racó del Corb” (no. 41, Litter

Grade "C", 0.167 items m^{-2}), while the lowest densities were observed at "La Faroleta" (no. 12, Litter Grade "B", 0.040 items m^{-2}). "Racó del Corb" is a gravel beach where daily cleaning operations are not daily performed and "La Faroleta", located at Tabarca Island, is characterized by a low affluence of users and high accumulations of *Posidonia oceanica* 'banquettes'. Average litter density in remote areas was 0.071 items m^{-2} in spring, and 0.085 items m^{-2} in summer. Lastly, remote areas show low beach litter concentrations (Fig. 6).

b) Rural: Ten sites were sampled. In spring, coastal sites obtained intermediate Litter Grades: 7 grade "B" and 3 grade "C". Very different results are observed in summer: 5 sites with grade "B", 3 grade "C" and 2 grade "D" (Fig. 5). Only one beach ("Calas del Cuertel") improved in summer season (from "C" to "B") in reference to the Litter Grade though the amount of beach litter was higher in summer (no. 15, Table 2). Five coastal sites became dirtier and/or more dangerous (no. 19, 26, 47 and 48, Table 2) and the other four were conserved to the same Litter Grade (no. 10, 33, 34 and 51, Table 2). Highest density was documented at "Agua Amarga" (site no. 19) in both seasons (0.373 and 0.661 items m^{-2} with grades "C" and "D") whilst the lowest density was observed at "El Pinet" in spring, and at "El Xarco" in summer with 0.014 and 0.022 items m^{-2} respectively, both with grade "B" (no. 10 and 33, Table 2). Average litter density ranged from 0.099 (spring) to 0.195 items m^{-2} (summer), i.e. from 200 to 417 items per 100 meters (Fig. 6a). Rural areas show greater data distribution than other areas for spring; summer appears to be an outlier that corresponds to the very polluted beach of "Agua Amarga" (previously mentioned), in this season data distributions are similar to urban areas (Fig. 6a).

c) Village: Seventeen sites in all. One belonged to Litter Grade "A", fourteen to grade "B" and two to grade "C" in spring. In addition, in summer, were observed fourteen sites graded as "B" and three "C" (Fig. 5). Litter Grade of village areas recorded very few variations: only two beaches (no. 1 and no. 39, Table 2) changed their grade negatively. Highest litter density was observed at "Cala dels Jueus" (spring) and "Babilònia" (summer) with 0.148 and 0.168 items m^{-2} correspondingly, while the lowest amount was recorded at "Cap Negret" in both seasons (0.005 and 0.024 items m^{-2}). Litter densities reached average values of 0.046 items m^{-2} in spring and 0.078 in summer (135 and 231 litter items per beach respectively, Fig. 6a). The distribution of the data is similar to the remote areas, despite this, village areas have some atypical value as it was the case of Tabarca Beach in spring or the beaches of Tabarca, El Torres and Babilònia in summer (Fig. 6a).

d) Urban: A total of twenty sites were classified in this category. In spring, most coastal urban sites (15) obtained grade "B", followed by grades "C" and "D" (4 and 1 sites). In summer there was an evidently negative trend in Litter Grade's progress: 9 sites with grade "B", 7 with "C" and 4 with "D" (Fig. 5). The density of litter items was higher at "Serragrossa" for both seasons (no. 22, Table 2) possibly because it was a fishing area close to a breakwater. During spring, litter density was highest at "San Gabriel" (Avg: 0.130 items m^{-2}) where a nearby stream was observed (no. 20, Table 2). In summer, the maximum concentration of litter was at the "Llevant" beach in Benidorm (no. 37, Avg: 0.217 items m^{-2}, Table 2), which attracts a high and constant number of tourists attracted by a great diversity of activities (Martinez-Ibarra, 2011). The lowest density of litter was found at "Cala Finestrat" with 0.011 items m^{-2} (spring, no. 36, Table 2) and "Almadraba" beach with 0.022 items m^{-2} (summer, no. 24, Table 2). Litter densities reached average values of 0.054 items m^{-2} in spring and 0.123 in summer, i.e. 234 and 268 litter items respectively (Fig 6a). These beaches have the highest averages of all typologies. In addition, there were two atypical values in summer (Fig. 6a), corresponding to two crowded beaches: Llevant and L'Arenal (no. 37 and 50, Fig. 1, Table 2). The greatest differences between spring and summer averages were in urban areas, followed by rural, village and remote areas (Fig 6b).

Considering the diverse beach typology and their associated, services/activities the differences that appear in litter composition are probably related to beachgoers. Examples in Table A.2 show clear differences in litter composition related to the presence/absence of people in remote and urban areas. Authors such as Cabezas-Rabadán et al. (2019) working in beach user's perceptions, demonstrated though questionnaires that young people preferred semi-natural and pebbly beaches such as "Granadella" and "Ambolo" (sites no. 48 and 49, Table 2) mainly because of their attractive coastal scenery, while elderly and families preferred urban and sand beaches (generally with more safety and facilities), and prioritized more water quality and sediment cleanliness, proximity from their houses, and presence of facilities. In the European context, this behaviour is related to preferences of beach users for choice a coastal site: safety, facilities, excellent scenery, good water quality and no litter (Williams & Micallef, 2009).

Litter grading indicated possible risk-related categories and Figure 5 showed that Grade was strictly related to beach typology. A total of forty-three sites obtained "good" litter grades ("A" and "B"), and thirteen sites received "bad" ones ("C" and "D") in the spring season. In summer, litter grades usually changed for the worse: zero sites had a grade "A", thirty-four sites a grade "B" and twenty-two sites with grades "C" and "D" (Fig. 5). The grade "A" (non-existent in summer) and "B" represents a good environmental condition. Although grade "B" is considered good, their management should not be ignored. Finally, grades "C" and "D" require immediate and appropriate management by the responsible municipalities. In addition, management should be emphasized in the summer period as the coast is generally dirtier than the previous season (Fig. 5 and Table 2).

Numerical results for each site showed a general increase in number of items (except for eight sites, Table 2). Litter Grade was not so precise in terms of quantity, but it reflected the dangerousness of a site according to its litter categories. For example, a site with a number of items between 49 and 499 was graded as "B" (general litter), so a beach can be "B" in spring with 50 items, and the same beach can still be "B" with 400 items in summer. Differently, there are beaches that have similar litter density but belong to different grades due to litter categories (Harmful Litter, Sewage Related Debris, etc.). Number of items and litter grade are complementary, for this, their values should be conjointly analysed (Table 2). Some sites reported lower amounts of litter in summer period, but litter grading worsened (e.g. sites no. 12 and 26, Table 2).

Among the seven categories evaluated (EA/NALG, 2000), ones that worsened their final classification were General Litter (i.e. cigarette butts, plastic bottles, cans, bottle caps, pieces of film plastic and paper, food packaging, etc.). Harmful Litter (i.e. broken glass) and Sewage Related Debris (SRD), i.e. cotton bud sticks, sanitary towels, etc. (Fig. 4). Other categories (e.g. Accumulations) also worsened at few places but were not responsible for the final grade obtained.

Application of these methodologies requires knowledge of the number of items and can maximize the importance of the smallest ones, e.g. cigarette butts. Despite their small dimensions, they can cause multiple harmful impacts, as evidenced by Kungskulniti et al. (2018). Some studies present data on litter weight, but this can lead to confusion due to the difference in size and type of material for each item. For example, in the study of Maziane et al.

(2018), cigarettes represented 25% in number, while in weight they represented only 0.8% of all sampled litter.

4.4. Statistical analyses: ANOVA, nMDS, PCA and Cluster

Relationships between seasonal litter distribution and beach typology were illustrated by box plots (Fig. 6a), which show that, in most cases, data groups are positively skewed with a few large outlier values, indicating the need to transform data values by log(x+1). The residuals of the two-factor ANOVA model with transformed data were tested for normality using Q-Q and histogram plots, and for homogeneity of variance using Bartlett's tests and a plot against fitted values, confirming the validity of the model. ANOVA showed very highly significant effects ($P<0.001$) for both factors (season and typology), but no significant effect of the interaction ($P=0.4$) indicating the effect of typology on the mean abundance of beach litter to be similar in both seasons. Differences between individual means were tested for significance using Tukey's HSD and 95% family-wise confidence intervals. Significant differences were found between spring and summer overall means, and between the following pairs of typologies: rural, urban and village versus remote, urban versus rural, village and urban versus rural. These results indicate strong differences in beach litter abundance both between the seasons and between the beach typologies sampled, although these differences were greater in the summer due to the increased numbers of visitors and the consequently higher numbers of litter items (Fig. 6b and Table 2). Remote areas, due to their difficult access and lack of facilities, generally reported fewer visitors, and litter related to beachgoers was only occasionally observed. Village areas generally had fewer visitors than urban areas, suggesting slower accumulation of litter and its effective withdrawal by the current cleaning management programs. Only when the number of visitors to these areas increased, did litter abundance reach values similar to those observed in urban areas: Tabarca beach was a clear example (no. 11, Table 2). Finally, Rural areas do not present significant differences in litter abundance with respect to urban areas, probably because clean-up efforts are not well implemented.

Nonmetric multidimensional scaling (nMDS) was performed to visualize multivariate patterns among coastal sites and litter observations in each season: sites close together on the plot have similar beach litter composition (Fig. 7). The polygon enclosing each beach type is much larger and more dispersed in spring than summer, especially for urban and village sites (Fig. 7). The disproportionate increase in the abundance of some beach user-related items in summer and increased cleaning effort are likely to have reduced the differences in litter content between urban and village sites. This methodology demonstrated differences and similarities between sites according to their litter composition (see examples in Table A.2). It should be noted in figure 7 that beaches located in the left part of the graphs usually are more contaminated (especially in the left-upper part). Beach typology and coastal drift can influence this difference, Finally, Cluster Analysis (CA) showed the dissimilarity (or similarity) of all sites for spring and summer, according to litter content (Fig. 9). The vertical axis represents the investigated sites and the horizontal scale on the dendrogram (Fig. 9) represent the distance or dissimilarity between them. The vertical position of the split, shown by a short bar, gives the hierarchical clustering of datasets. Typology and Litter Grade for each site were also observed. For example, observing thresholds 0.2 and 0.7 to compare spring and summer results, different sectors (light grey colour) can be identified according to Bray-Curtis dissimilarity and the most similar sites (dark grey colour) were recognized according to beach litter data (Fig. 9). In sector 3 of the Spring Cluster there were sites very similar in litter composition (in blue squares: 7 small groups composed of 2, 3 and 4 coastal sites were identified). While in sector 1 of the Summer Cluster, 8 groups composed of 2 to 7 sites were identified in red squares. When comparing the two clusters of Figure 9, it can be seen how differences are reduced in summer because there are fewer sectors and more similar sites. Sites with the greatest similarity presented different typologies: in spring there were urban (11), village (3) and rural (3) sites, while in summer prevailed urban (15), village (7) and rural (4). It should be emphasized that these rural sites generally were highly frequented, and remote areas were not present in these groupings. This indicated once again that littering considerably increased according to the number of visitors.

4.5. Some considerations for Coastal Management

Effective measures must be taken to reduce beach pollution, such as:

- Specific environmental education programs must be carried out at different levels for public and private entities. The educational system can play a huge role in this context. For this message to be enforced involves a long time period but it can be done with full scale government insistence. The ‘drink driving’ and ‘seat belt safety’ campaigns’ carried out in the UK have been an unqualified success in cutting down deaths/accidents (a similar trend has occurred in Spain). A change in the culture of people in order to stop littering must be the aim of all governments.

indicative of a sewage pathway to the beach. This is indicative of the fact that municipal collectors are probably illegally discharging wastewaters into the beach or some outfall is too short or broken, causing items to be transported back to the beach by currents and waves. Urgent actions are required to solve the problem.

- More restrictive laws and environmental campaigns (especially in summer) focused on beach smokers. Change can be attained. For example, the presence of unsightly cigarette butts can be eliminated by a realistic ban on beach smoking. New Jersey USA, has banned smoking apart for a small reserved beach area; Florida is considering the same. Ariza and Leatherman, (2012) have given good account of the USA situation. At Bibione beach Italy, smoking for 400m from the water's edge to the back shore is going to be prohibited from May 2019; Queensland, Australia has banned smoking at all public beaches (The Guardian, 2019). In Spain, a group of beaches has been declared "smoke-free", specifically 110 beaches in 2018, almost all located in Galicia. Although, today there is no law prohibiting smoking on the Spanish beaches.

- Implementation, in several languages, of panels at the beach regarding environmental information. These must be sited at the entrance to the beach, with the panels being not too cluttered and having both pictures and words.

- Implementation of systems to capture litter transported in streams to prevent its arrival at the sea. Also, provision of adequate litter bins at appropriate intervals along a beach and regularly cleaned are imperative items to try to take control of beach litter. A ratio of 1:150 beach users is recommended (Williams & Micallef, 2009) so that a preliminary sorting of litter is done at source (Fig. 10a). Bins could be colour coded for groupings, easily visible and not too much of a distraction in the environment.

- Environmental management of recreational fishing from the beach. Beach zoning constitutes sound management. As swimming and fishing are not compatible bed fellows, if boating occurs at a beach then boat channels separating bathing and boating/ jet ski related activities should be clearly delineated, mainly using lines with marker buoys but they also should be able to specify land-use sub-zones such as dog-free zones and conservation areas. Other recreational activities, such as, picnicking and camping should also be controlled.

- Implementation of specific cleaning operations at remote/rural sites. Local NGOs, voluntary beach cleans etc. could be implemented in order to help cut down litter found on these beaches. The Ocean Conservancy in the USA and Marine Conservation Society, UK are leaders in this field in their respective countries.

- A long-term monitoring programme related to base-line studies should be implemented to detect early signs of any environmental decay.

- If smoking is to be allowed, then disposal at beach access points of recycled metal cans to be used as ashtrays (Fig. 10b). Cardboard ashtrays are a quick and easy solution, but are less durable and involve unnecessary cardboard production (Fig.10c). Plastic ashtrays can be reused, but are often non-existent or insufficient in number.

- Deposit refund systems. These are currently in use in, for example, Iceland where drink bottles taken to a designated spot can be exchanged for small coins. The items, as well as being removed from the beach can then be recycled.

- Tourist taxes when employed could also be used to ensure clean beaches.

5. CONCLUSIONS

This paper investigates litter composition, seasonal distribution in spring (201,700 m^2, a total of 10,101 litter items, average 0.062 items m^{-2}) and summer: (20,857, average 0.116 items m^{-2}) and litter origin at 56 coastal sites along the Mediterranean Sea beaches of Alicante Province (SE Spain) coastline. Sites covered “remote” (9), “rural” (10) “village” (17) and “urban” (20) bathing areas. Plastics were the main component found seasons (82.6 in spring, 83.5% in summer), but cigarette butts were prolific in their numbers (4,607 to 12,843 respectively) and the bulk of litter can be attributed to beach goers, wastewater discharges (6.5 in spring, 2.5% in summer) and fishing activities consisted of 3.1 and 1.2% respectively of the litter items found.

The paper proposes a number of actions that, if implemented, could significantly reduce the abundance of several litter items and the proposed methodologies can help coastal managers at the study area and at other similar areas, to take the best decisions for different beach types. Beach cleanliness assessment based on the Litter Grade methodology was an effective and useful tool to evaluate the local coast’s efficiency of cleaning operations and when required, to propose improvements and/or retire beach awards. However, stopping litter at source must be the mantra for effective beach management. Implementation of environmental education, is essential in schools and media.

Each coastal sector is different due to its particular management regime, cleaning strategy, local culture, number of visitors, policy and other aspects. Plastics and cigarette butts prevail in tourist zones despite the geographic location. The lack of collaboration of some municipalities in research topics is an actual problem in the advancement of knowledge. Anyone should be able to have access to public information; municipalities should not ignore scientific studies that provide so much data and ideas to improve coastal management.

Future works can be devoted to assess the effectiveness of beach clean-ups by carrying out surveys before and after beach cleaning operations. An interesting topic would be to carry out several surveys at the same place during one day to see if litter item amounts increase or decrease according to beach user frequentation.

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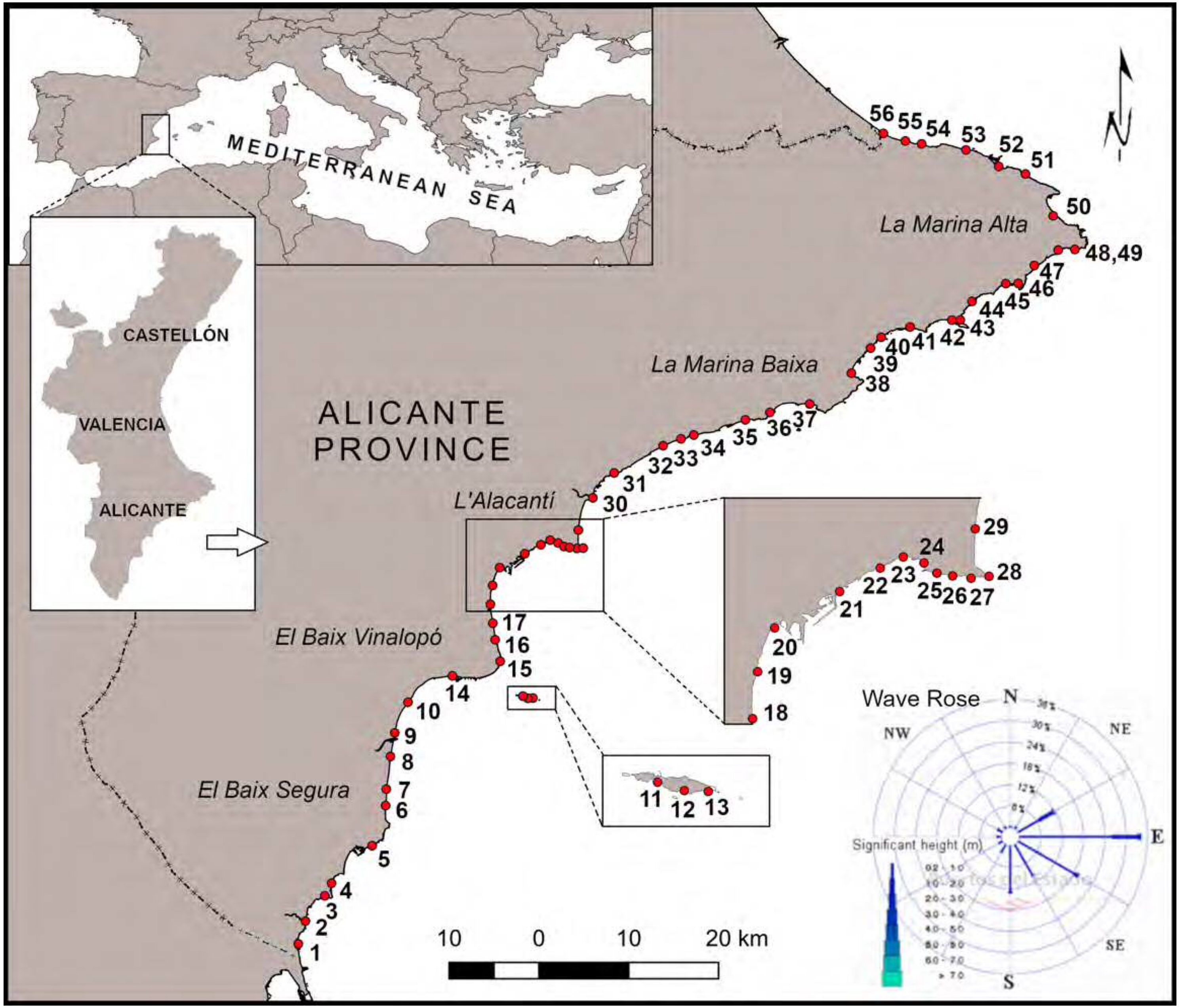
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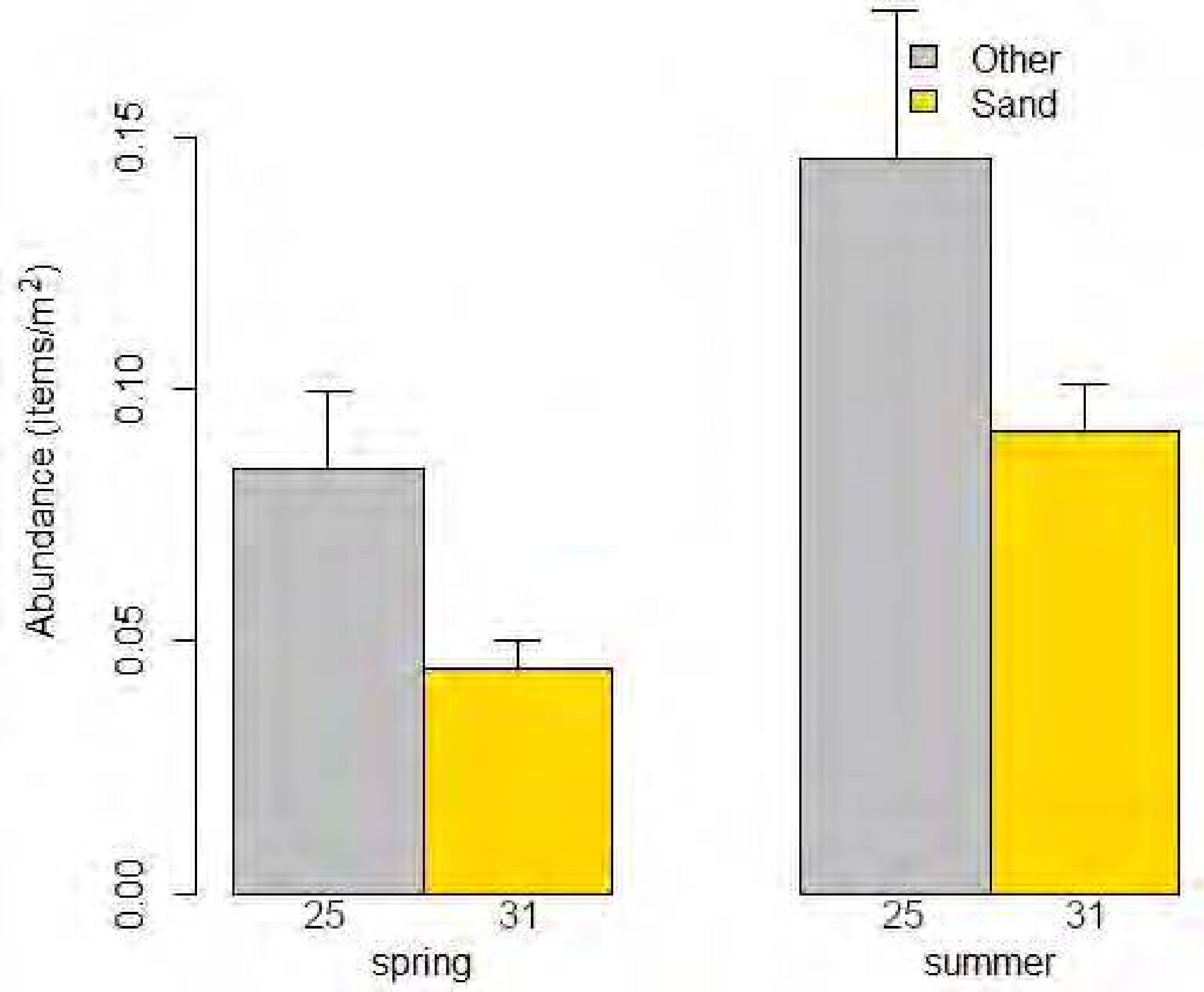
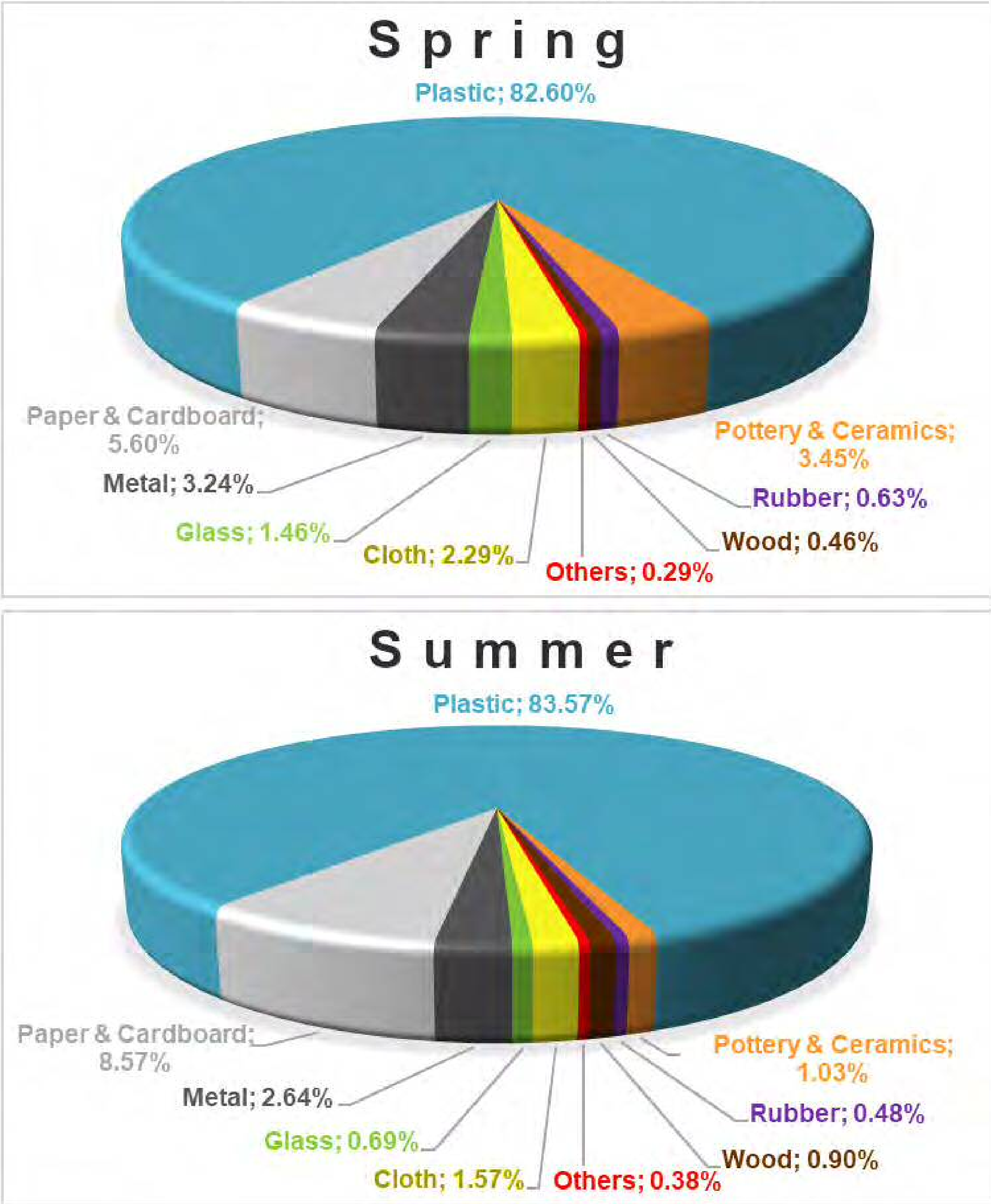
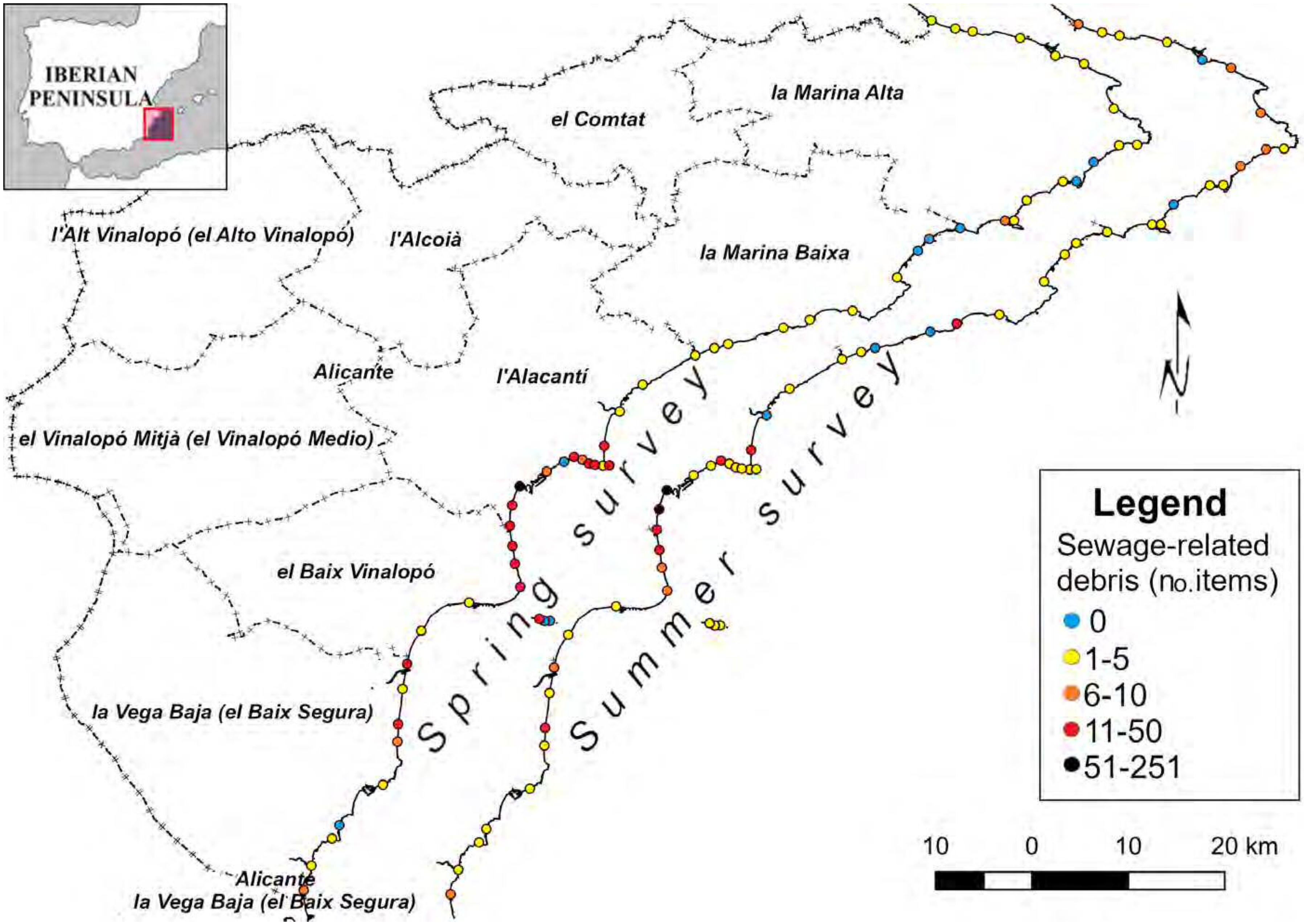
54
55
56



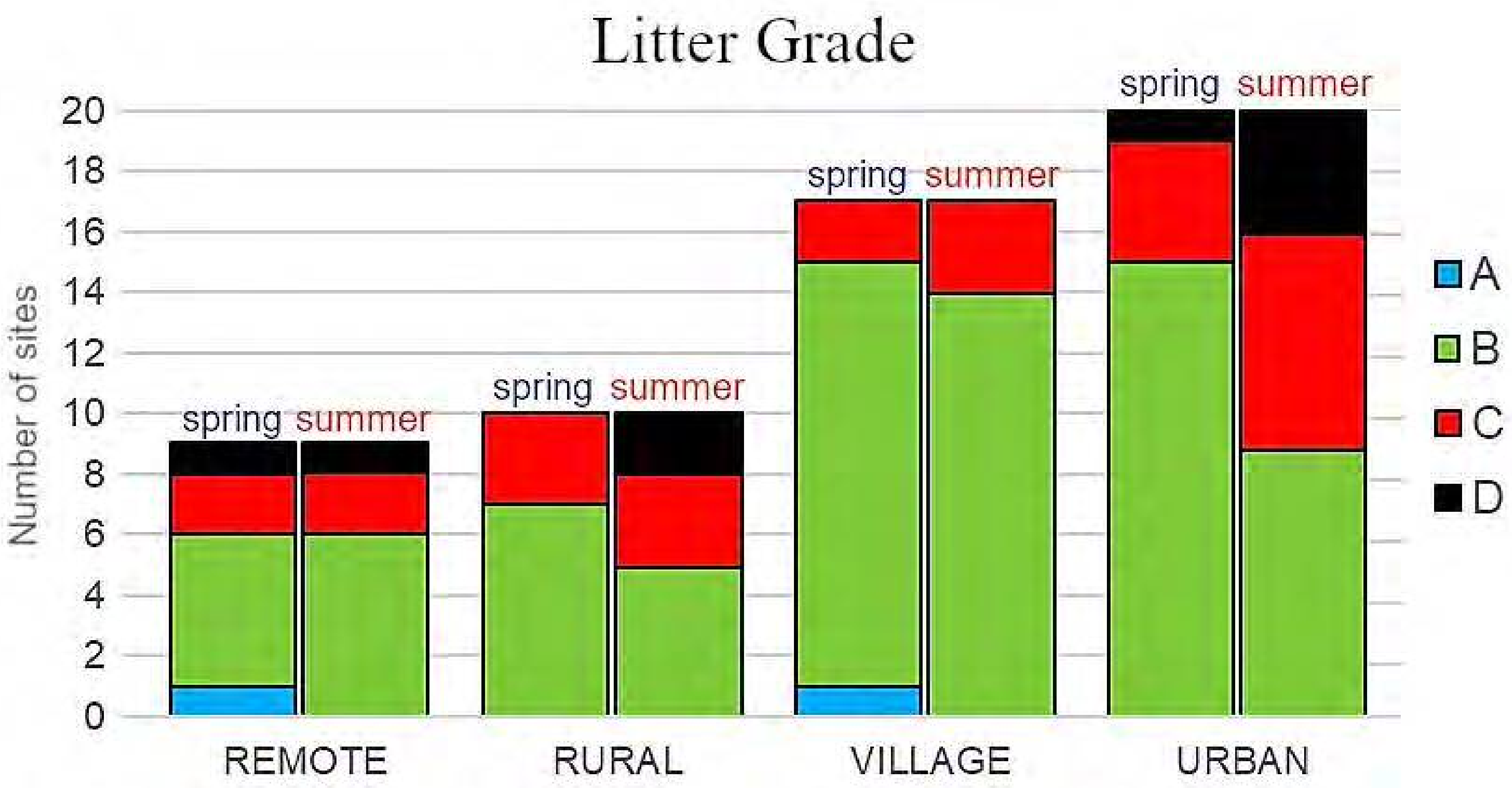
Other
Sand
Abundance (items/m^2)
0.00
0.05
0.10
0.15
25
31
spring
25
31
summer

Beach litter composition

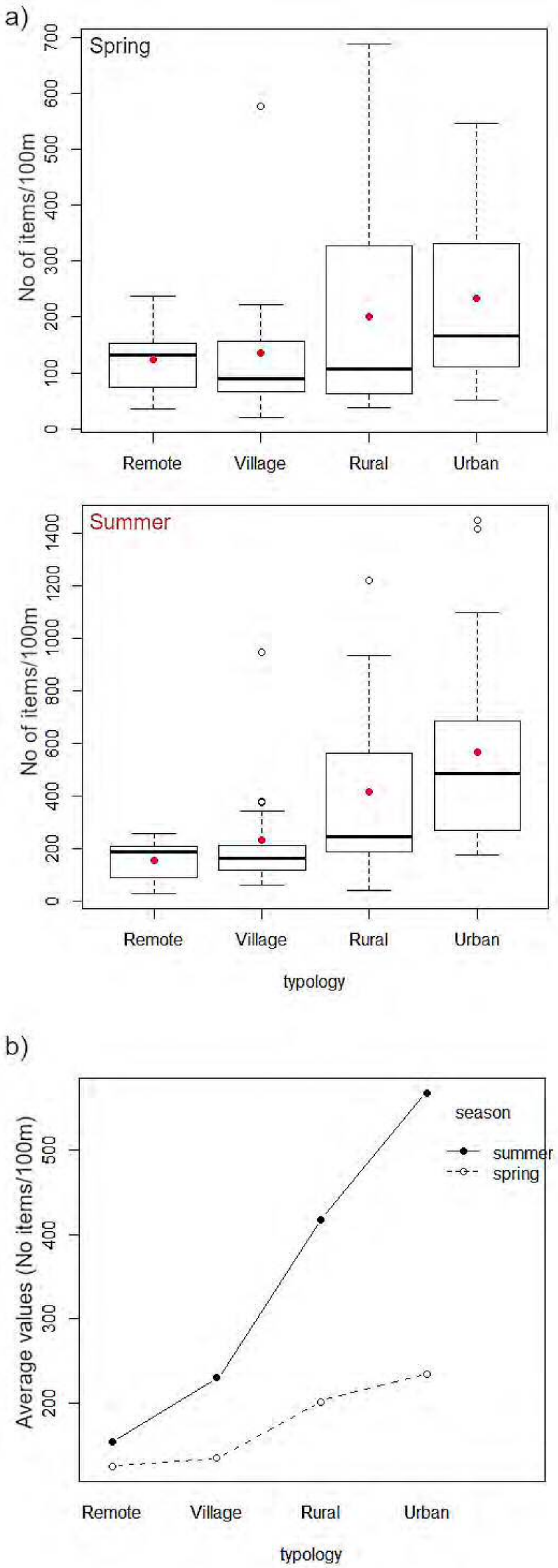


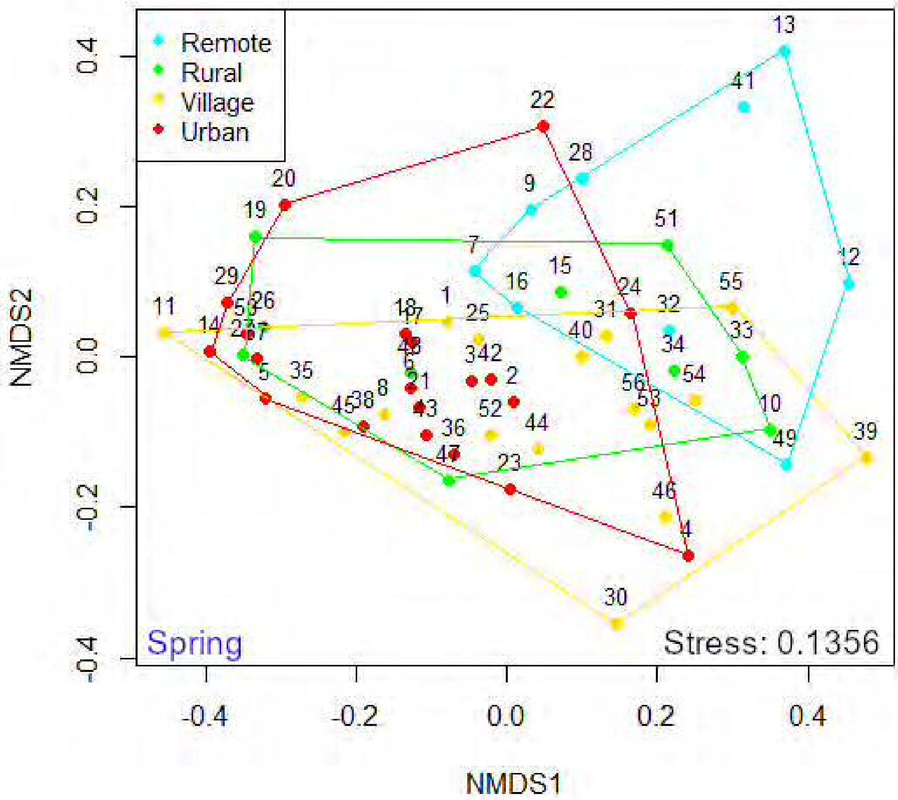


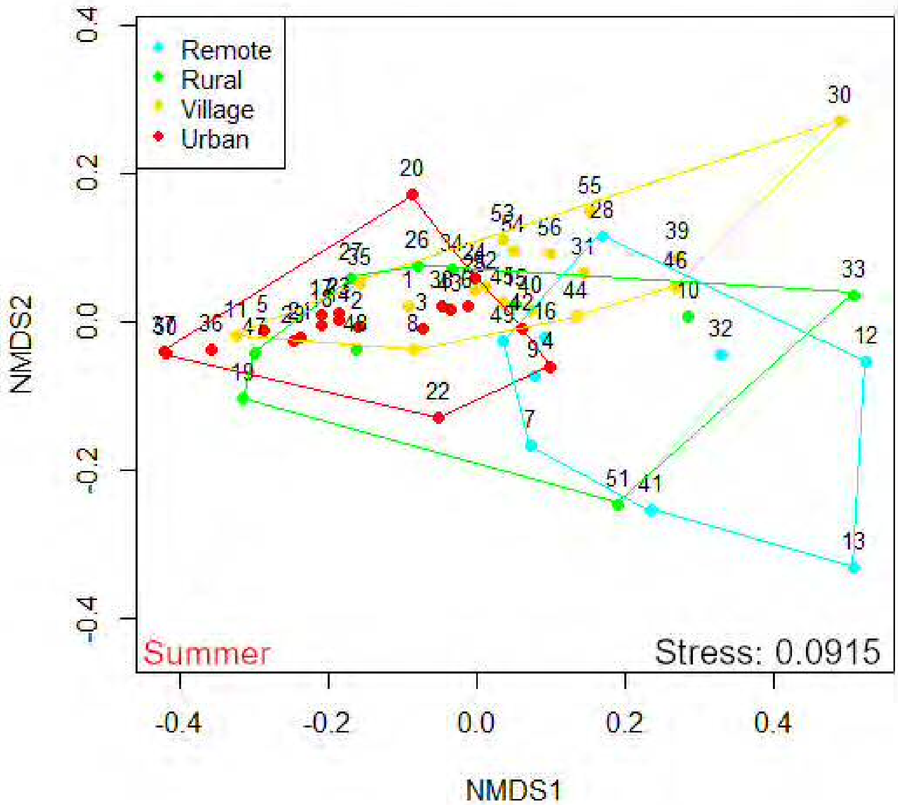
IBERIAN PENINSULA
el Comtat
la Marina Alta
l'Alt Vinalopó (el Alto Vinalopó)
l'Alcoià
la Marina Baixa
Alicante
l'Alacantí
el Vinalopó Mitjà (el Vinalopó Medio)
el Baix Vinalopó
la Vega Baja (el Baix Segura)
Alicante
la Vega Baja (el Baix Segura)
Spring survey
Summer survey
Legend
Sewage-related debris (no.items)
0
1-5
6-10
11-50
51-251
10 0 10 20 km

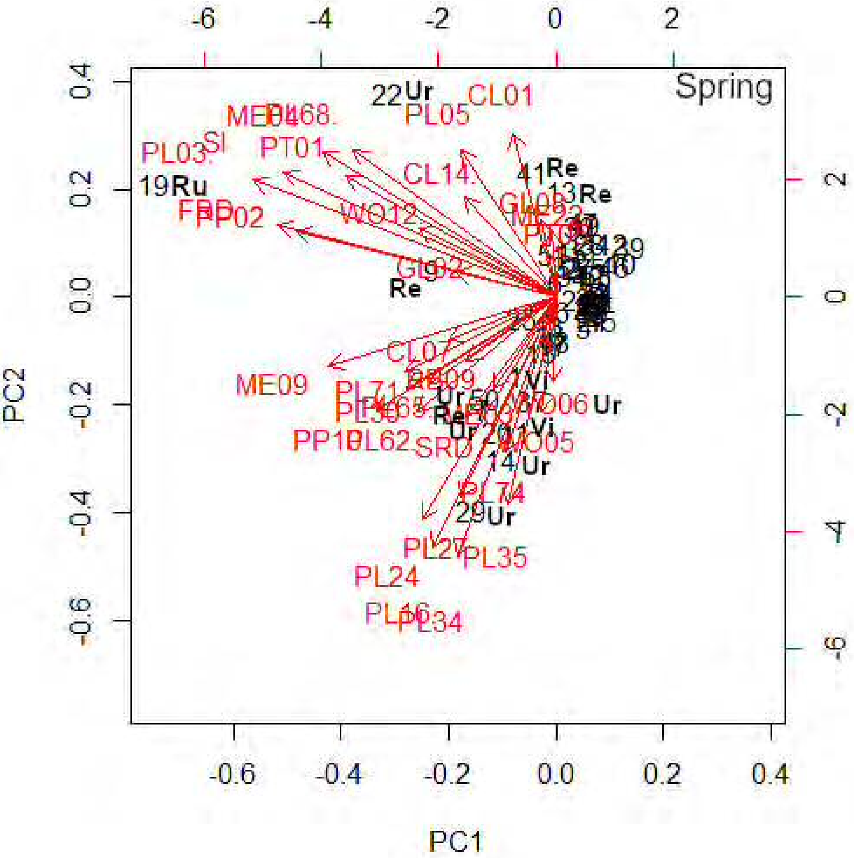


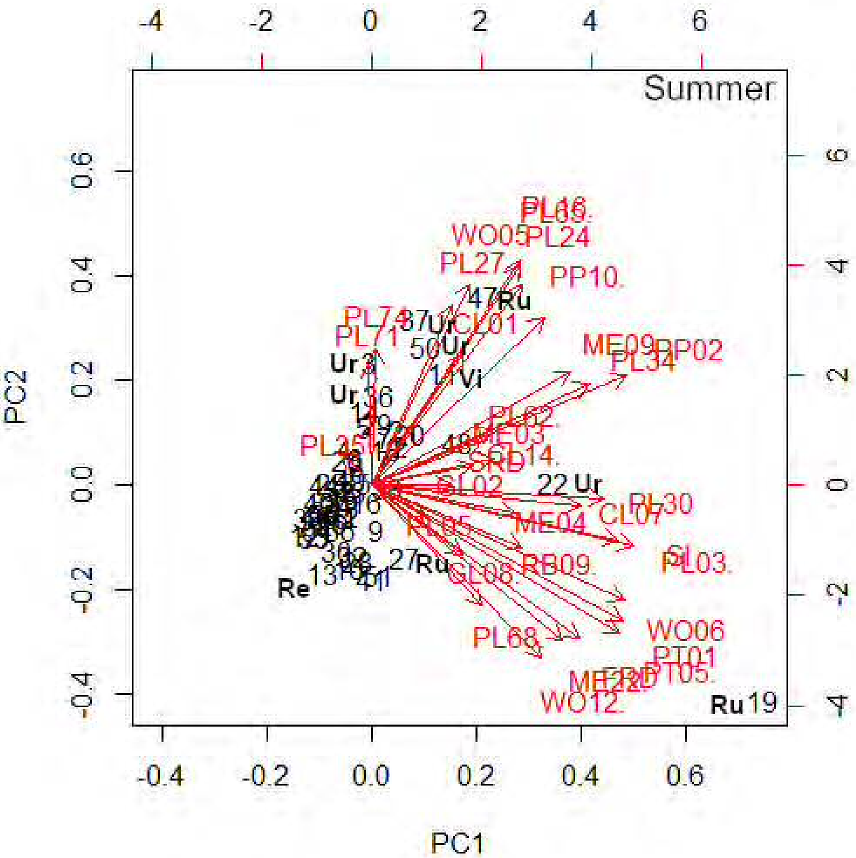
Litter Grade
Number of sites
20
18
16
14
12
10
8
6
4
2
0
spring
summer
REMOTE
RURAL
VILLAGE
URBAN
A
B
C
D

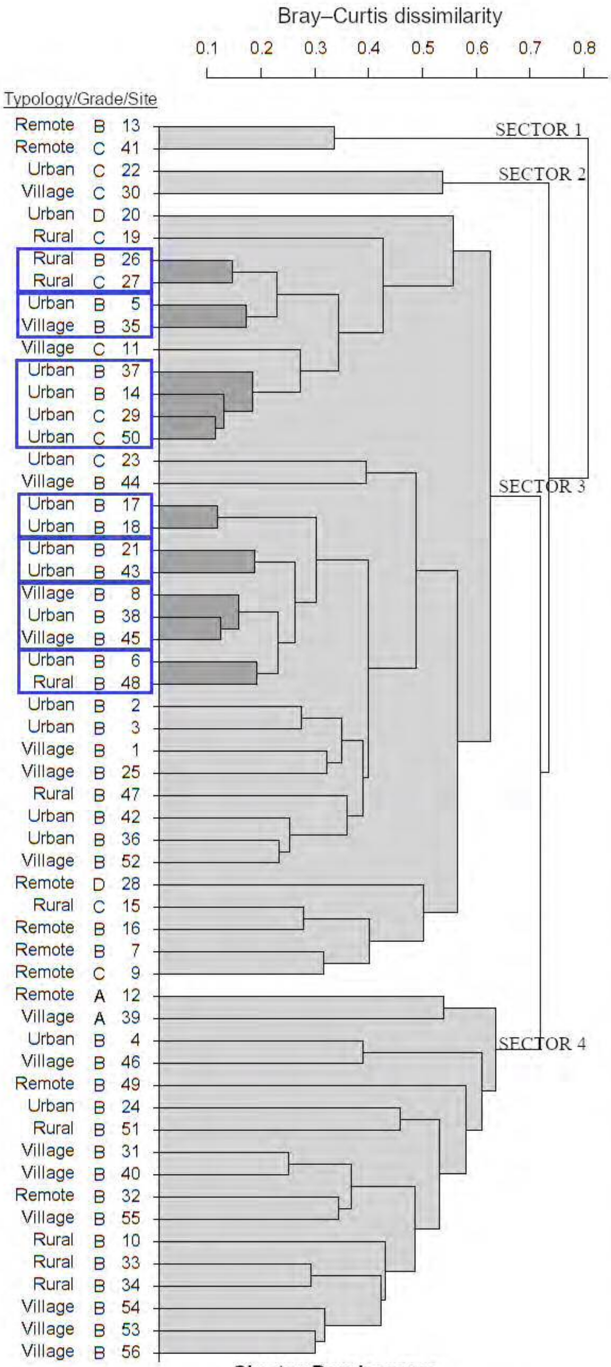

a)
Spring
No of items/100m
0
100
200
300
400
500
600
700
Remote
Village
Rural
Urban
Summer
No of items/100m
0
200
400
600
800
1000
1200
1400
Remote
Village
Rural
Urban
typology
b)
season
summer
spring
Average values (No items/100m)
200
300
400
500
Remote
Village
Rural
Urban
typology


Remote
Rural
Village
Urban
Spring
Stress: 0.1356
NMDS1
NMDS2

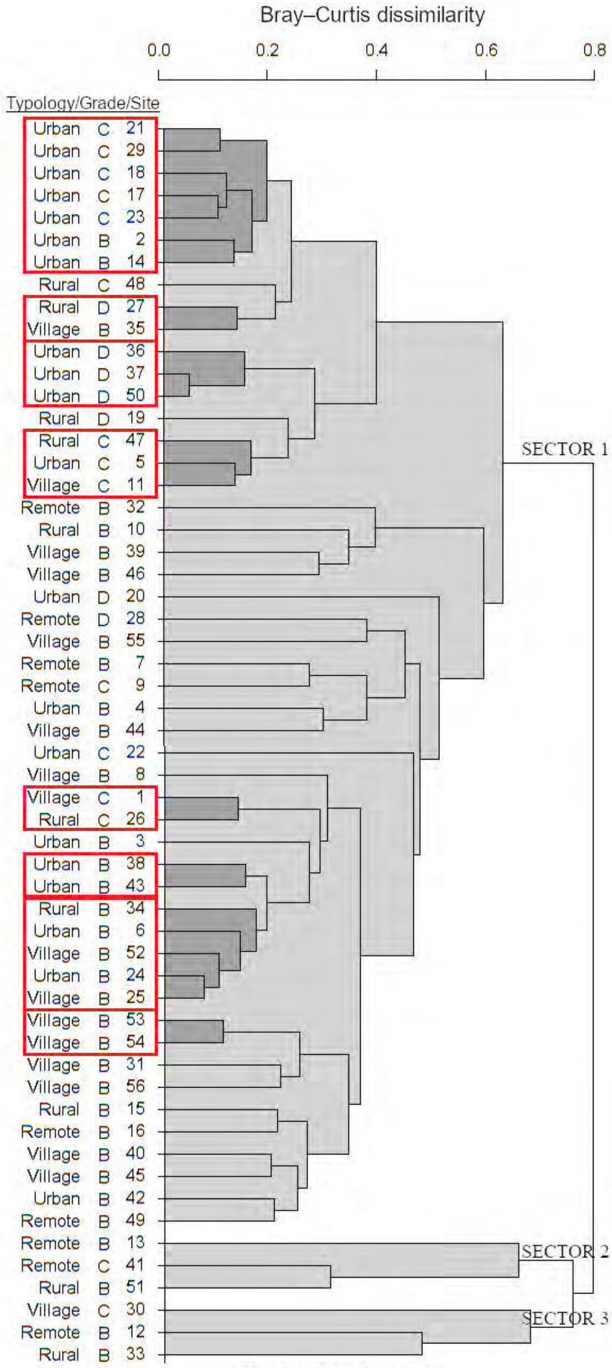

Remote
Rural
Village
Urban
Summer
Stress: 0.0915
NMDS1
NMDS2


Spring
PC1
PC2
-0.6
-0.4
-0.2
0.0
0.2
0.4
-6
-4
-2
0
2
CL01
PL05
PT01
PL03
CL14
WO12
ME09
CL07
PP10
PL62
SRD
WO06
WO05
PL24
PL35
PL34


Summer
PC1
PC2
-0.4
-0.2
0.0
0.2
0.4
0.6
-4
-2
0
2
4
6
WO05
PL24
PL27
PP10.
PL71
CL01
PL34
PL62
SRD
GL02
ME04
CL07
PL30
RB09.
GL08
WO06
PT01
PT05.
PL68
WO12.



Cluster Dendrogram
Method: "Average"
Spring



Cluster Dendrogram
Method: "Average"
Summer


a)
b)
CENDRIER
ASHTRAY
STOP POLLUTION
Prenez moi comme cendrier
c)
FREE • Beachashtrays • FREE
Butts on the beach are a B****!

CODE	Description	No items. Spring	No items. Summer
CL01	Clothing	15	11
CL07	Rope & Strings /net pieces (non-nylon)	71	108
CL14*	Cloth pieces	73	63
FRD	Fishing-related debris	314	260
GL02	Other Bottles	9	7
GL08*	Glass fragments	138	137
ME03	Bottle caps, lids & pull tabs	110	145
ME04	Drink cans	51	70
ME09	Foil wrappers	95	274
ME22*	Metal fragments	44	20
PP02	Cardboard	47	92
PP10*	Paper fragments	440	1646
PL03*	Bags (e.g. shopping)	143	77
PL05	Drinks (bottles, containers and drums)< 2L	82	63
PL16*	Knives, forks, spoons, stirrers, straws, cups	290	445
PL24	Cigarettes, butts & filters	4607	12843
PL27	Food wrappers	452	415
PL30	Caps/lids	267	279
PL34	Crisp/sweet packets and lolly sticks	127	170
PL35	Toys & party poppers	18	49
PL62*	Hard plastic pieces	732	724
PL65*	Film Plastic pieces	199	1016
PL68*	Foamed Plastic pieces	224	429
PL71	Clamps	33	37
PL74	Another caps/lids	42	34
PT01	Construction material (brick, cement, pipes)	299	198
PT05*	Ceramic fragments 0 - 2,5 cm	49	17
RB09*	Rubber fragments	31	26
SI	Smoking Items	23	41
SRD	Sewage-related debris	655	520
WO05	Ice lolly sticks	7	62
WO06	Chip forks, chopsticks & toothpicks	6	73
WO12*	Wood fragments	28	41
	Others	380	448
	Total	10101	20840

*Several related groups

No Map	Coastal site	Beach Typology	Coastal type*	Items per m^{-2} spring/summer		No items per beach (100 m) spring/summer		Litter groups per beach (100 m) spring/summer		Litter Grade spring/summer	
1	Las Higuericas	Village	1	0.052	0.080	220	342	38	31	B	C
2	Mil Palmeras	Urban	1	0.020	0.097	101	495	23	39	B	B
3	Cabo Roig	Urban	1	0.035	0.084	144	350	33	30	B	B
4	La Estaca	Urban	1	0.012	0.043	51	175	22	23	B	B
5	Playa del Cura	Urban	1	0.068	0.192	270	759	21	26	B	C
6	Torrelamata	Urban	1	0.051	0.077	165	250	26	37	B	B
7	Les Ortigues	Remote	1	0.064	0.070	235	258	41	34	B	B
8	Babilònia	Village	1	0.071	0.168	157	374	17	25	B	B
9	Els Tossals	Remote	1	0.130	0.119	238	217	54	29	C	C
10	El Pinet	Rural	1	0.014	0.037	37	97	18	21	B	B
11	Tabarca	Village	1, 2, 3, 5	0.098	0.161	577	946	35	34	C	C
12	Faroleta	Remote	2, 3, 5	0.050	0.040	36	29	19	13	A	B
13	Platja Gran	Remote	2, 3, 5	0.123	0.065	84	44	23	12	B	B
14	Gran Playa	Urban	1	0.078	0.076	496	488	27	33	B	B
15	Calas del Cuartel	Rural	1, 4, 5	0.050	0.078	119	187	31	31	C	B
16	El Carabassí	Remote	1	0.037	0.045	153	187	30	30	B	B
17	Arenales del Sol	Urban	1	0.071	0.187	210	554	27	27	B	C
18	El Saladar	Urban	1	0.050	0.131	230	607	30	34	B	C
19	Agua Amarga	Rural	2, 4	0.373	0.661	688	1221	59	70	C	D
20	San Gabriel	Urban	1	0.130	0.114	534	468	38	34	D	D
21	El Postiguet	Urban	1	0.025	0.116	140	655	18	38	B	C
22	Serragrossa	Urban	2, 3, 6	0.184	0.416	205	463	41	47	C	C
23	Albufereta	Urban	1	0.021	0.115	92	485	21	29	C	C
24	Almadraba	Urban	1	0.009	0.021	90	208	26	29	B	B
25	Cala dels Jueus	Village	4, 5	0.148	0.167	186	210	38	29	B	B
26	Cala Cantalars	Rural	4	0.158	0.132	327	273	25	23	B	C
27	Cala Palmera	Rural	4	0.162	0.213	333	438	29	37	C	D
28	Cap de l'Horta	Remote	4, 5	0.034	0.042	135	166	25	36	D	D
29	Playa San Juan	Urban	1	0.057	0.075	547	718	38	37	C	C
30	Riu Sec	Village	2, 3	0.048	0.024	122	60	22	19	C	C
31	Morro Blanc	Village	1, 5	0.032	0.042	90	118	27	22	B	B
32	Carritxar	Remote	3	0.054	0.064	75	88	29	28	B	B
33	El Xarco	Rural	3	0.033	0.022	57	38	24	18	B	B
34	Bon-Nou	Rural	1, 2	0.021	0.071	63	215	22	16	B	B
35	El Torres	Village	1, 2, 3	0.055	0.095	222	380	21	27	B	B
36	Cala Finestrat	Urban	1	0.011	0.113	106	1099	17	34	B	D
37	Llevant	Urban	1	0.059	0.217	391	1449	32	34	B	D
38	Racó de L'Albir	Urban	2	0.034	0.058	166	281	24	29	B	B
39	Cap Negret	Village	2, 3	0.005	0.024	21	95	11	32	A	B
40	L'Olla	Village	2, 3	0.057	0.133	77	180	18	19	B	B
41	Racó del Corb	Remote	3	0.118	0.167	131	186	36	40	C	C
42	Morelló	Urban	1, 4	0.062	0.091	126	186	19	30	B	B
43	Cala de la Fossa	Urban	1	0.055	0.121	115	254	15	31	B	B
44	Cala Fustera	Village	1	0.048	0.098	75	152	15	22	B	B
45	L'Ampolla	Village	1	0.040	0.047	157	186	17	26	B	B
46	El Portet	Village	1	0.029	0.058	38	75	14	22	B	B
47	Cala del Moraig	Rural	1, 2, 3	0.036	0.357	94	933	22	46	B	C
48	Granadella	Rural	2, 3	0.078	0.223	196	562	31	46	B	C
49	Ambolo	Remote	2, 3	0.026	0.151	36	209	22	33	B	B
50	L'Arenal	Urban	1	0.044	0.125	503	1417	33	34	C	D
51	Les Rotes	Rural	3,4	0.066	0.154	90	209	24	28	B	B
52	Marineta Cassiana	Village	1	0.036	0.078	93	203	22	30	B	B
53	Les Marines	Village	1	0.020	0.046	66	155	22	22	B	B
54	Els Molins	Village	1	0.015	0.042	58	163	26	22	B	B
55	Almadrava	Village	1	0.014	0.025	65	119	17	17	B	B
56	Les Deveses	Village	1	0.014	0.034	68	164	23	36	B	B

Coastal type: 1 Sand; 2 Gravel; 3 Boulders; 4 Rocky shore; 5 *Posidonia oceanica* 'banquettes'; 6 Partially artificial coast.

	Category	Type	A	B	C	D
1	Sewage Related Debris	General	0	1-5	6-14	15+
		Cotton Buds	0-9	10-49	50-99	100+
2	Gross Litter		0	1-5	6-14	15+
3	General Litter		0-49	50-499	500-999	1000+
4	Harmful Litter	Broken Glass	0	1-5	6-24	25+
		Other	0	1-4	5-9	10+
5	Accumulations	Number	0	1-4	5-9	10+
6	Oil		Absent	Trace	Nuisance	Objectionable
7	Faeces		0	1-5	6-24	25+

Categories: General Sewage litter - items include: feminine hygiene products (sanitary towels, tampons and applicators, contraceptives. toilet paper, faeces of human origin. **Cotton Bud Sticks** – harmless in themselves but they denote a sewage input. **Gross Litter** (at least one dimension >50 cm) - include: shopping trolleys, pieces of furniture, road cones, large plastic or metal containers; bicycles, prams; tyres; and large items of processed wood e.g. pallets. Driftwood is not included. **General litter** (all other items <50 cm in dimension) - include drink cans, food packaging, cigarette packets, etc. **Potentially Harmful Litter** (dangerous to either humans or animals using the beach) - includes: sharp broken glass (counted as a separate category), medical waste (e.g. used syringes), colostomy bag, sharps (metal wastes, barbed wire, etc.), soiled disposable nappies, containers marked as containing toxic products, other dangerous products such as flares, ammunition and explosives ammunition and dead domestic animals. **Accumulations of litter** – discrete aggregations of litter clearly visible when approaching the survey area, either as a result of being blown by the wind or dumped by users of the beach, and in the high water strandline, often in seaweed. **Oil and other oil like substances** - all oil waste (mineral or vegetable), either from fresh oil spills or the presence of weathered oil deposits and tarry wastes. **Faeces (Non Human) -** Dogs **(**sheep or horse faeces are not be counted).

Site	Season survey	Beach Litter Categories							
		Paper fagments	Plastic cutlery	Plastic Bottles	Cigarettes	Wrappers	Caps & lids	Foamed pieces	All other items
13	Spring	1	0	15	0	0	9	30	29
41	Spring	3	0	27	0	0	1	36	64
37	Summer	63	30	3	1203	26	6	2	129
50	Summer	73	33	0	1166	10	3	6	126