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Baseline

Beach litter in Ecuador and the Galapagos islands: A baseline to enhance environmental conservation and sustainable beach tourism

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ABSTRACT

The presence and characterization of beach litter was investigated, according to the EA/NALG (2000) methodology, at 59 sites along four provinces of Ecuador, i.e., three continental and the Galapagos Islands Province. The methodology, which has been verified in several countries, was used to classify beaches into four grades (from "A" – excellent to "D" – poor) according to the content of nine types of litter. Twenty-two sites (i.e., 37% of total) obtained Grade "C", 18 (31%) Grade "B", 12 (20%) Grade "A", and 7 (12%) Grade "D". The province that showed excellent litter grades was the Galapagos Islands where 88% of beaches obtained Grade "A", whereas Santa Elena and Esmeraldas provinces presented the worst beaches in terms of litter content and abundance. Environmental authorities should focus more attention on continental beaches by improving adequate cleaning operations to make them more attractive to national and international tourism.

At a world scale, tourism has exhibited a virtually uninterrupted growth with time (Klein et al., 2004 and UNWTO, 2017). In 2017, receipts linked to international tourism at a world scale grew by 2.6% in real terms compared with that in the previous year: 32.8 million international tourists and 1.4 million visitors visited South America and Ecuador, respectively (UNWTO, 2017), with the Galapagos Islands playing an important role in it with 167,011 foreign visitors (i.e., 10% of total, DPNG, 2018). Further, tourism in Ecuador represents the third source of nonoil income, thus accounting for 5.1% of the gross domestic product (GDP) (MINTUR, 2017). In the Galapagos Islands, tourism is the main contributor to the economy (Kerr, 2002), and the revenues received in past years generated more than 65% of GDP in the Galapagos Islands, i.e., c. 85 million USD/year (Epler, 2007). Tourism in the Galapagos Islands relies on international visitors, mainly from the US and Europe, who are particularly interested in beaches, and these islands are well known for their natural beauty and unique wildlife (MINTUR, 2018).

At a world scale, beaches are considered as a major attraction for more than half of the tourists interested in the "sun, sea and sand (3S) destinations," and a clean beach is one of the five main preferences/priorities for tourists (Doods and Kelman, 2008; Williams and Micallef, 2009; Zielinski et al., 2019). Litter enters the sea (from rivers, illegal dumping, beach users, etc.), and it is transported by waves and currents (Prevenios et al., 2018). Consequently, litter impact is increasingly reported worldwide (Schneider et al., 2018), even in the most remote environments on the Earth, such as the deep ocean floors and the polar region (Bergmann et al., 2017). Sometimes, remote beaches are home to litter pollution at levels similar to those of beaches situated closer to more populated coastal areas (Bergmann et al., 2017). Of special importance is the concentration of plastic items on beaches, estuaries, and open oceans: it has been recognized as a current century global challenge (UNEP, 2014) and a global problem that impairs human health (e.g., can cause injuries and cuts; Whiting, 1998), ecosystems, and landscape (UNEP, 2005; Papatheodorou, 2012; Rochman et al., 2013). Despite previous assumptions, the management of litter on beaches is currently particularly related to tourist purposes rather than to environmental or sanitary policies (Botero et al., 2017).

Ecuador is one of the smallest countries in South America, with an area of 270.670 km^2. Its coastal area includes the continental one, 1000 km long, which includes the provinces of Esmeraldas, Manabí, Santa Elena, Guayas, and El Oro (Fig. 1) and the insular area of Galapagos. Along Esmeraldas, Manabí, and Santa Elena, the coastline is essentially composed of sandy low sectors with limited cliffed sectors and that of Guayas and El Oro provinces is composed of wide mangrove

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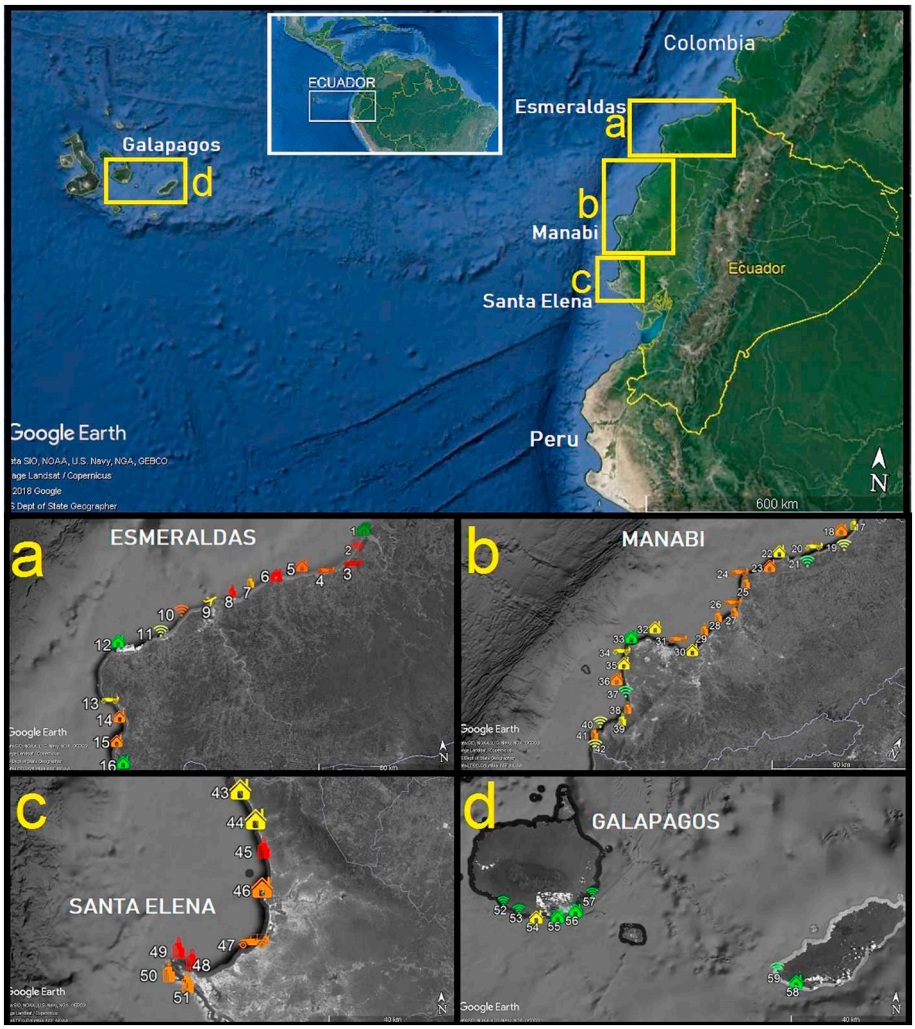

Fig. 1. Study area with the 59 beaches analyzed in Ecuador.
Location of the 59 studied beaches in Ecuador (key zoom-boxes: a = Esmeraldas; b = Manabi; c = Santa Elena; d = Galapagos; Key symbols: = remote, = rural, = Village, = urban. Key colors: Green = Grade "A", Yellow = Grade "B"; Orange = Grade "C"; Red = Grade "D"). (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

swamps and muddy sectors (INOCAR, 2011). The Galapagos Islands include 234 emerged landforms (islands, islets, and rocks, DPNG, 2018). The coast is composed of sand pocket-beaches and volcanic rocky sectors, and the timeline of their formation, emergence, and paleogeography remains highly uncertain (Geist et al., 2014). Since its declaration as a World Heritage Natural Site by UNESCO in 1978, the Galapagos Islands have acquired the reputation of being one of the last pristine natural paradises on Earth and are famous worldwide mainly for their biodiversity and, only to a lesser extent, for their geological heritage (Jordá-Bordehore et al., 2016). In recent years, the Ecuador Government has promoted tourism to improve the life quality of inhabitants (Rivera, 2017). Therefore, Ecuador, especially Quito and the Galapagos Islands (Taylor et al., 2009), is becoming an appealing destination in Latin America (Diaz-Christiansen et al., 2016).

Despite an increasing 3S tourist potential in Ecuador, information about beach environmental quality remains scarce. Therefore, an extensive field survey was carried out in February 2018 in three continental coastal provinces (Esmeraldas, Manabí, and Santa Elena) and the insular province of the Galapagos Islands (Table 1), which includes the largest number of tourist beaches of the country. Fifty-nine beaches were investigated; Manabí Province hosted most of them, followed by Esmeraldas, Santa Elena, and the Galapagos Islands. Beach litter grade was determined by counting the number and type of items identified along a sampling unit according to the EA/NALG (2000) methodology. This technique records litter items in a 100 m wide sector, generally located in the central part of the beach and extended 50 m either side of the access point from the strandline to the beach landward boundary, usually dunes, cliff base, or a seawall or other anthropogenic structures. Beach litter items are divided into nine categories, from general litter and sewage-related debris, to oil and *feces*.

After counting all types of items, the beach is graded on a scale ranging from "excellent" to "poor" (grades "A" to "D", respectively), with the overall beach litter grade given as the lowest obtained grade. For example, a beach could have "A" grade (i.e., the best score) in all categories, but even if one category has a "D" grade (i.e., the worst score), then an overall "D" grade is given to that beach. In this way, the technique enables managers to concentrate on items that need to be eliminated to achieve higher grades. This method has been applied in many places worldwide, such as Cuba (Botero et al., 2017), Brazil (Corraini et al., 2018), Colombia (Williams et al., 2016; Rangel-Buitrago et al., 2018), Morocco (Maziane et al., 2018), and Wales (Williams et al., 2014). This study represents a novelty investigation in Ecuador, as it deals with a topic of great interest in the country because of the necessity of preserving and maintaining the environmental quality of the numerous available coastal protected areas (essentially located in the Galapagos Islands) and the need for improving the quality of tourist beaches. Further, this investigation covers a large portion of the country's coastline.

Results showed that 22 beaches (i.e., 37% of investigated sites) presented Grade "C," 18 (31%) Grade "B," 12 (20%) Grade "A," and 7 (12%) Grade "D" (Table 2). The province that showed excellent scores was the Galapagos Islands, with 88% of beaches presenting Grade "A," whereas the worst beaches in terms of litter presence were observed at Santa Elena and Esmeraldas provinces, which had most of beaches

Table 1
Location and characteristics of investigated beaches.

Number location map	Beach/province[a]	Type	Tourism[b]	GRADE EA/ NALG (2000)
1	Las Peñas (E)	Village	L	C
2	Africa (E)	Remote	L	D
3	Paufi (E)	Rural	L	D
4	Rocafuerte (E)	Rural	L	C
5	Rioverde (E)	Village	L	C
6	Bocana del Lagarto (E)	Village	L	D
7	Las Palmas (E)	Urban	N	C
8	Tonsupa (E)	Urban	N	C
9	Atacames (E)	Urban	N	B
10	SUA (E)	Urban	N	B
11	Same 1 (E)	Remote	N	B
12	Same 2 (E)	Village	N	A
13	Punta Galera (E)	Rural	N	B
14	Estero Platano (E)	Village	L	C
15	San Francisco (E)	Village	L	C
16	Mompiche (M)	Village	I	A
17	Pedernales (M)	Urban	N	B
18	Punta Fraile (M)	Village	N	C
19	Punta Prieta (M)	Remote	N	B
20	Tasaste (M)	Rural	N	B
21	Cabuyal (M)	Remote	N	A
22	Don Juan (M)	Rural	N	B
23	Canoa (M)	Village	I	C
24	Playa del sol (M)	Rural	N	C
25	San Vicente (M)	Urban	N	C
26	San Clemente (M)	Rural	N	C
27	Crucita (M)	Urban	N	C
28	Tarqui (M)	Urban	N	C
29	El Murciélago (M)	Urban	N	C
30	San Mateo (M)	Village	L	B
31	Tiñosa (M)	Rural	L	C
32	Santa Marianita (M)	Village	N	B
33	San Lorenzo (M)	Village	L	A
34	San José (M)	Rural	L	B
35	Puerto Cayo (M)	Village	N	B
36	Machalilla (M)	Village	L	D
37	Los Frailes (M)	Remote	I	A
38	Puerto López (M)	Urban	N	C
39	Salango 1 (M)	Urban	N	B
40	Salango 2 (M)	Remote	N	B
41	Las Tunas (M)	Urban	N	C
42	Las Tunas (M)	Remote	N	B
43	Ayampe (S)	Village	I	B
44	Olon (S)	Village	I	B
45	Montañita (S)	Urban	I	D
46	Ayangue (S)	Village	I	C
47	Playa Rosada (S)	Rural	N	C
48	Salinas San Lorenzo (S)	Urban	N	D
49	Salinas Chipipe (S)	Urban	N	D
50	Puntilla de Santa Elena (S)	Urban	N	C
51	Punta Carnero (S)	Urban	N	C
52	Playa Mansa (S)	Remote	I	A
53	Tortuga Bay (G)	Remote	I	A
54	Los Alemanes (Punta Estrada) (G)	Village	I	B
55	Playa La Estación (G)	Village	I	A
56	Playa Ratonera (G)	Village	I	A
57	El Garrapatero (G)	Remote	I	A
58	Playa Mann (G)	Village	I	A
59	Punta Carola (G)	Remote	I	A

[a] Province. E: Esmeraldas, M: Manabí, S: Santa Elena, G: the Galapagos Islands.
[b] Origin. L: local, N: National; I: International.

ranked as Grades “C” and “D” (Fig. 2). Finally, the Manabi Province had an equal number of beaches with Grades “B” and “C.” An early recommendation for tourist and environmental authorities should be to focus more attention on continental beaches, where the majority of beaches with high litter pollution grades are located.

Beaches were also classified according to their type and tourist use. Beach typology was classified into four categories on the basis of increasing human occupation and use: remote, rural, village, and urban (Williams and Micallef, 2009). In this study, 11 beaches were classified as remote, 17 as urban, 10 as rural, and 21 as village (Table 2). The majority of remote, urban, and rural beaches were located at Manabí (n = 5, 8, and 6, respectively), and at Esmeraldas and Manabí provinces, the most represented were village beaches (n = 7), and at the Galapagos Islands Province, a balance was observed between remote (4) and village (4) beaches. Results show that Grade “A” sites were found only in remote and village beaches, with six beaches each, although village beaches had beaches with almost similar grades “A”, “B”, and “C” (Fig. 2). On the contrary, urban and rural sites had the majority of numbers showing Grade “C” (n = 10 and n = 5, respectively), thus evidencing a weakness in litter cleanup programs at urban areas, as well as a strong relation between population and beach litter presence. At rural beaches, litter is probably discharged by visitors and is washed onto the beach by waves and currents: its content increases with time because the nonperformance of beach cleaning operations in part is due to the difficulty of access, as observed along the coast of Andalusia by Mooser et al. (2018).

Regarding tourist usage, beaches were classified according to the dominant origin of visitors, i.e., local, national, and international. This study highlights that 31 beaches were principally visited by national visitors, 15 by international, and 13 by local (MINTUR, 2017). Fig. 3 shows specific trends at each province: the Galapagos Islands Province is dominated only by international visitors (n = 8; 100%), Manabí by national (n = 19; 73%), and Esmeraldas has a balance between local (n = 8; 50%) and national (n = 7; 44%) visitors. To sum up, the greatest abundance of remote, urban, and rural beaches is observed at Manabí Province, whereas Esmeraldas and Manabí provinces essentially presented village beaches. The Galapagos Islands Province has remote and village beaches, which attract 241,800 national and particularly international visitors (DNPG, 2018). These results suggest that beaches with international visitors represent the cleanest places probably because they have the best waste management actuations, as reported in other investigations (e.g., Botero et al., 2017; Corraini et al., 2018). Exceptional scores recorded at the Galapagos Islands Province are also linked to the small litter inputs from i) rivers (which are almost inexistent) and ii) beachgoers who seem to have an elevated respect for the environment – indeed favored by several educational actuations carried by local authorities such as the emplacement of educational panels and bins at all beaches.

The results were opposite at Santa Elena Province, where even beaches with international tourists had low cleanliness scores: 22 beaches showed Grade “C” and 7 Grade “D.” However, beaches essentially visited by national and local visitors did not show a common, clear pattern, as evidenced in Fig. 3:

- Esmeraldas' beaches presented Grades “A,” “B,” and “C” and the ones with local visitors recorded Grades “C” and “D”;
- Santa Elena's beaches are predominately frequently visited by national tourists and share Grades “B” and “C”;
- Manabi's beaches had mainly national visitors, with Grades “B” and “C” in a similar proportion, whereas the few beaches with local visitors had Grades “B,” “C,” and “D”;
- The Galapagos Islands had no beaches with predominance of national or local visitors.

In brief, the worldwide pattern that cleanest beaches are those with international tourism is confirmed also in Ecuador, but no conclusions could be extracted for beaches with national and local visitors. As observed in Cuba (Botero et al., 2017), an explanation could be that national and local authorities are interested only in those beaches with economic revenues and pay less attention to those beaches frequented by local residents or national tourists; in the case of Ecuador, an

Table 2
Evaluation of beach litter characteristics and distribution along the coast of Ecuador.

Region	Province	Beach	Grade				Type				Tourism		
			A	B	C	D	Re	Ur	Ru	Vi	L	N	I
Mainland	Esmeraldas	16 (27%)	2	4	7	3	2	4	3	7	**8**	7	1
	Manabi	26 (44%)	3	**11**	**11**	1	**5**	**8**	**6**	7	5	**19**	2
	Santa Elena	9 (15%)	0	2	4	3	0	5	1	3	0	5	4
Island	Galapagos	8 (14%)	**7**	1	0	0	4	0	0	4	0	0	**8**
Total Ecuador		59	12 20%	18 31%	**22**	7	11	17	10	**21**	13	**31**	15
					37%	12%	19%	29%	17%	**36%**	22%	**53%**	25%

(Re = Remote; Ur = Urban; Ru = Rural; Vi = Village; L = Local; N = National; I = International; in bold the highest values in each category).

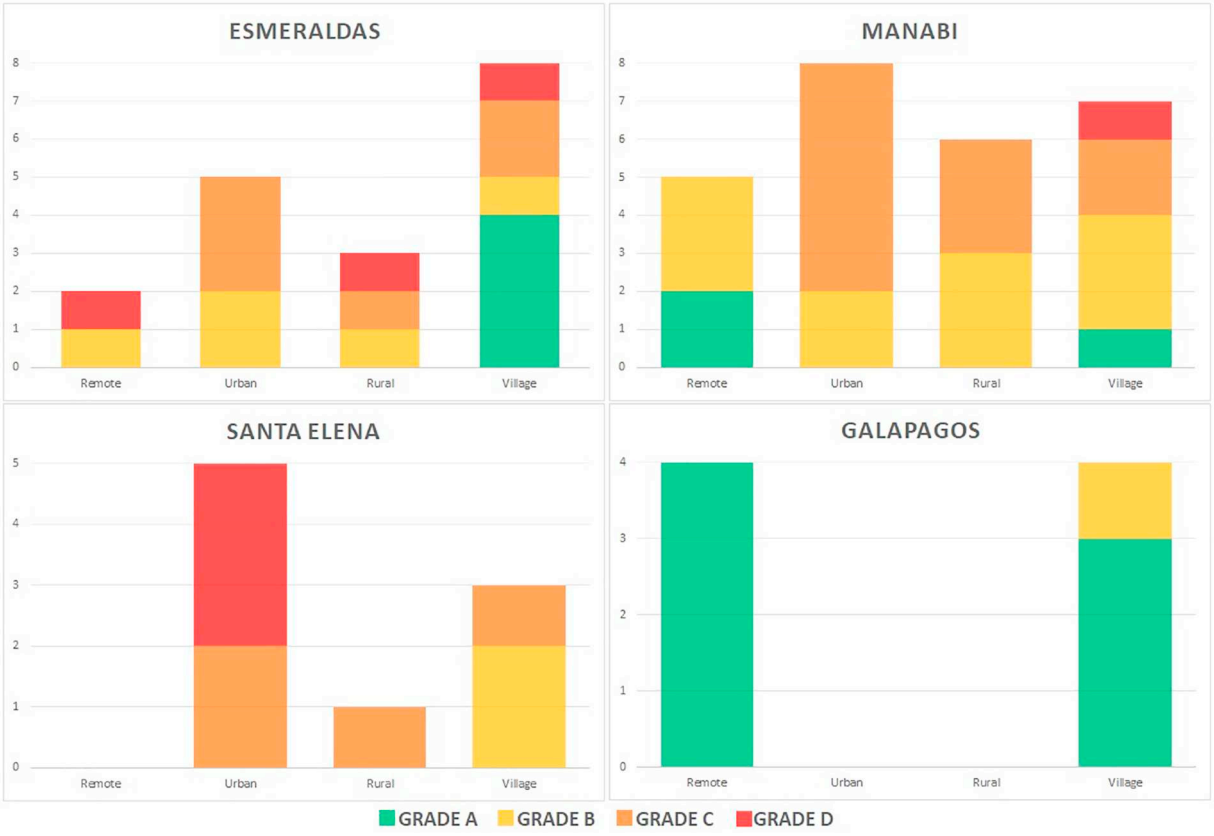

Fig. 2. Beach litter grade and typology at the 59 investigated sites.

interpretation could be that environmental policies are led more by economic drivers than the life quality and health of the population.

With regard to litter categories observed along the Ecuadorian beaches (Table 2), "general litter" was the most common type of residue; only 25% of beaches obtained Grade "A" for this category of litter and 37% showed Grades "C" and "D," which are values lower than those in other countries such as Cuba (Botero et al., 2017), Colombia (Williams et al., 2016), or Wales (Williams et al., 2014). In fact, the Esmeraldas and Manabi provinces had a majority of "general litter" in Grade "C," which evidences an urgent need to improve appropriate cleanliness services. Other categories with low scores were "Accumulations" and "Gross litter" (i.e., elements of large dimensions such as tyres, bins, and wood). The former achieved Grade "A" only at 69% of Ecuadorian beaches, with several beaches graded "B" and "C" in Esmeraldas (n = 9) and Manabi provinces (n = 8). The latter had Grade "A" at 71% of beaches, with the Esmeraldas and Manabi provinces showing the lowest scores. It is not easy to compare these results with observations carried out in other countries because, except for Botero et al. (2017) study, the vast majority of published research based on the EA/NALG (2000) technique did not analyze litter grade in each category (Rangel-Buitrago et al., 2018; Corraini et al., 2018; Maziane et al., 2018; Rangel-Buitrago et al., 2018; Williams et al., 2016; Williams et al., 2014; Tudor and Williams, 2008; Tudor et al., 2002). Nevertheless, results presented in this paper suggest different means by which beach managers can improve the quality of beaches: i) Implement a better cleanliness service for general litter at all beaches; ii) Prevent the habit of local residents and national/international tourists of abandoning litter on the beach; and iii) Identify and control gross litter dumping on beaches. If these measures would be implemented to increase one grade in each of these three categories, "General litter" will increase to 63% Grade "A" beaches (37% more), "Accumulations" to 90% (20% more), and "Gross litter" to 88% (17% more), indeed a strong motivation for managers (Fig. 4).

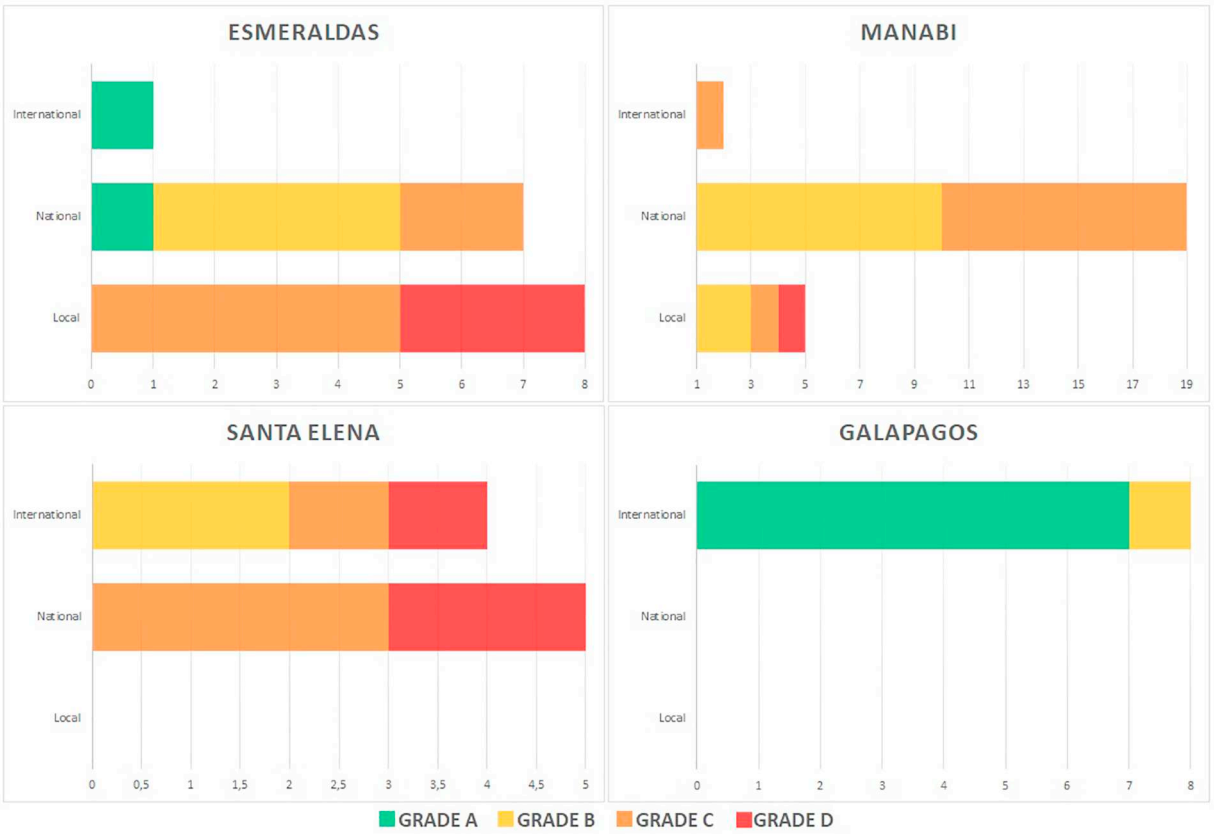

Fig. 3. Beach litter grade and tourist use at the 59 investigated sites.

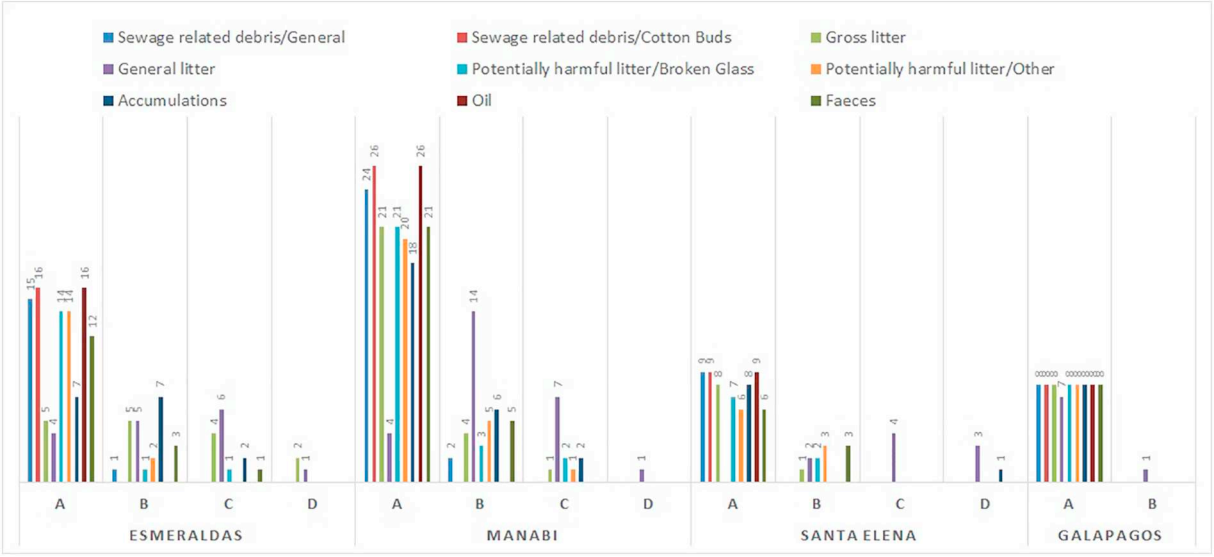

Fig. 4. Beach litter categories identified in Ecuador.

As a general overview, the most littered beaches were in the continental coast, where the environmental quality of Esmeraldas, Manabí, and Santa Elena provinces is greatly affected by litter issues. Human activities related to beach use together with litter transported by local drainage systems are interpreted as the main sources. Therefore, beach management should be based on strategies to eliminate or at least reduce litter sources, as suggested by several authors (Šilc et al., 2018; Botero et al., 2017; Williams et al., 2014; Zielinski et al., 2019). From an environmental conservation viewpoint, coastal managers should improve beach cleaning and reduce sources of potentially general and gross litter, especially in beaches with national and local tourists. If the government wants to develop tourism as an important economic activity for the country (Rivera, 2017), then more efforts must be focused on improving environmental quality of those beaches with a major tourist purpose. This work may serve to recall the political commitment (Jones, 2013) made by Ecuadorian government to strengthen the institutional relationships among stakeholders at different levels of society (government, academia, private sector, NGOs, and communities) related to tourism and environment. Through an integrated approach to regulation, investment, and law enforcement, this commitment aims to prevent beach pollution and promote high-quality tourism.

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