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Litter Reduction during Beach Closure in the Context of the COVID-19 Pandemic: Quantifying the Impact of Users on Beach Litter Generation

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Abstract: This study aimed to quantify marine litter before and during the COVID pandemic found on urban touristic beaches closed to beachgoer access in northeastern Brazil. Litter identification and quantification was conducted during April, June, and August 2019, when 3583 items were sampled, and replicated during the same months in 2020, when access to the beaches studied was prohibited and a significant reduction in the amount of litter was found, 1812 items (49% decrease). Transects were used to monitor and classify litter according to its source, namely: autochthonous (litter that was locally discarded) and allochthonous (litter from other sites and sources). All beaches were classified as "very clean" and presented a smaller amount of litter during the beach closure period. The highest total marine litter reduction between the periods studied was 83%, while autochthonous litter in particular showed the most significant reduction, 88%. The comparison between the quantity and type of litter found in both periods showed greater specific anthropic pressure from beach users.

Keywords: beach management; coastal tourism; environmental quality; solid waste management

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1. Introduction

Marine litter is defined as any persistent manufactured or processed solid material discarded, disposed of, or abandoned in the marine and coastal environment [1]. The presence of marine litter on beaches can cause environmental, ecological, social, economic, and public health impacts [2]. These occur, for example, by means of the entanglement of animals, ingestion, biological dispersion of exotic species, aesthetic or landscape deterioration, decreased recreation and tourist attractivity, risks to beachgoers, increased costs to public cleaning, among others [3–6].

The management of beach litter is a complex problem because littering has multiple sources, and policies may vary between and within countries. Beach litter can be locally discarded, disposed of, or abandoned by beach users (here called "autochthonous" litter) or can originate from other sites, in areas distant from where it is found, being carried by marine and coastal currents, rivers, streams, rainfall-runoff or urban sewage pipes (here called "allochthonous" litter) [7–10]. One example of the autochthonous litter is the one originated from recreational activities that sometimes predominate on beaches, especially

in the ones where intense tourism occurs [11]. This source predominance is even more noticeable close to beach kiosks or where beach vendors sell food and drinks [12,13].

Although the source of litter may vary, several authors correlate high populational densities to high concentrations of litter on beaches and adjacent environments [14–16]. In addition to this, local activities, such as the ones related to tourism, may heavily influence the amount of litter found in individual beaches or shoreline sectors. A higher number of users often reflects in a higher amount of litter found during the high season as opposed to during the low season in touristic beaches [17].

There are several measures proposed for marine litter management, including systematic monitoring, integration of marine litter management to economic and land use planning policy, strategic investment for litter control, raising public awareness, elimination or reduction of prevalent and persistent litter items consumption, among others. Many authors also support the idea that the success of interventions depends on the reduction of the gap between science, policy, and society [18].

Some unexpected occurrences can present themselves as an opportunity for researchers to better understand how different measures can affect beach litter pollution differently. Coronavirus disease 2019 (COVID-19) is an infectious illness caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) [19]. Its outbreak started in 2019, but was officially declared a pandemic by the World Health Organization on 11 March 2020, leading many countries to adopt various social distancing measures in order to reduce spreading. In Brazil, restrictions regarding access to beaches and other public areas were desynchronized and independent from each other, rather than coordinated by the federal government. According to an official note published by the Brazilian Supreme Court, in face of this lack of coordination, all government entities are responsible to adopt measures to benefit the Brazilian population and mitigate the impacts of the pandemic [20]. Therefore, restrictions resulted from local initiatives proposed by municipal and state governments, and their duration and restrictiveness varied from place to place. Some authors argue that the decrease in beach use, attributable to these restrictions, has led to a significant reduction in the amount of litter found on the sand, to the recovery of vegetation, and to noise reductions, among others [21–23].

Furthermore, several studies conducted during the current pandemic have sought, for example, to investigate the rethinking and optimization of the use of plastics [24], to understand the losses and generation of food waste [25], and to monitor variation in water and air quality [21,22], thus demonstrating the need to seek for more sustainable and regenerative models [26].

Considering what was exposed above, after this long period of confinement and restrictions, and because these are outdoor environments, usually associated with health promotion and leisure-related practices, beaches will possibly be one of the most sought out environments in the post-pandemic period [27]. The pollution caused by the presence of marine litter affects beach recreational quality and represents one of the main factors for loss of recreational attractivity of beaches [28,29]. Thus, solid waste management is essential to reduce inappropriate beach littering and to guarantee the environmental quality of this ecosystem.

The objective of the present study was to assess the amount, source, and change in marine litter pollution in urban touristic beaches located in northeastern Brazil, before and during beach closure to both local population and tourist access due to the COVID-19 pandemic.

2. Materials and Methods

2.1. Study Area

In addition to being the Bahia state capital, the municipality of Salvador was chosen for this study especially because it presents not only a high annual flow of visitors from other municipalities of the state of Bahia, traveling to do business or to visit relatives, but also has a high flow of visitors from other states of the country and other countries for tourism purposes [30]. Despite its appeal, marine litter can be found on Salvador beaches both underwater [11], and on the sand, as macro-litter [13] and micro-litter [31].

Despite the fact that Salvador was the first national capital and therefore has several historical and cultural monuments, traditionally the most important tourism segment is beach recreation, followed by historic-cultural tourism [30]. This scenario may be the result of its approximately 50 km of beautiful beaches, along the Atlantic and the Todos os Santos Bay shorelines, combined with having one of the lowest annual temperature range values of the world, varying between 20° and 34 °C [32]. The beaches of Salvador are also one of the main public leisure areas for the approximately 3.5 million inhabitants of its Metropolitan Region. All of this contributes to an intense use of these areas throughout the year.

In order to conduct the present study, the beaches selected were among the most intensely used by tourists and local beachgoers (Figure 1). In addition to this, there was the fact that they are located in different geographical regions within the municipality, therefore encompassing various socioeconomic profiles and geoenvironmental conditions (Table 1). Another selection criterion used was that beaches should be located far from major punctual solid waste sources and urban sewage (i.e., urban river mouths, sewage pipes etc.). Therefore, based on these criteria, the beaches of Farol de Itapuã, Porto da Barra and Ribeira were chosen (Figure 2 and Table 1). In addition, these beaches were one of the main targets of the municipal government, which determined that public areas should be closed as a strategy to avoid people agglomerations and reduce the contamination rate by SARS-CoV-2 ([33]).

All beaches assessed in the present study were characterized as touristic, urban, and strongly anthropized, presenting an intense use almost throughout the year with important increase in beachgoer flow during austral summer, peaking between December and February. This type of beach is characterized as being a public space strongly affected by human influence and occupation, where several socio-environmental and economic uses and interests converge, both by the local population and visitors [34,35].

The Farol de Itapuã beach is located on the Atlantic shoreline of Salvador, roughly 20 km away from the city center (Figure 2). Given the area's important natural resources—such as beaches, dunes, lagoons and coconut trees—and its high cultural value, the district of Itapuã has honed its own symbolic capital that sets the area apart from other districts in Salvador. This beach presents intense recreational use, with an available area of 4 to 10 m^2 per user [36]. These authors also stated that the presence of marine litter on this beach was one of the main problems indicated by beachgoers (tourists and local population).

Located on the Atlantic shoreline of Salvador, adjacent to the entrance of the Todos os Santos Bay, is the Porto da Barra beach (Figure 2). Being one of the main postcards of the city, it has a high symbolic, cultural, and historical relevance. Porto da Barra is located between two rocky promontories, partly sheltering it from incoming waves and forming a cove that is highly appreciated for bathing and recreational activities. Approximately 83% of the beachgoers interviewed in a study considered the beach to be polluted, despite its high touristic and recreational attractivity [37]. This is a factor that may compromise, in the long term, the attractiveness and touristic vocation of this beach.

Figure 1. Overview of the three beaches selected for the present study located in the municipality of Salvador, state of Bahia, Brazil. All of them are intensely sought after by tourists and local beach-goers.

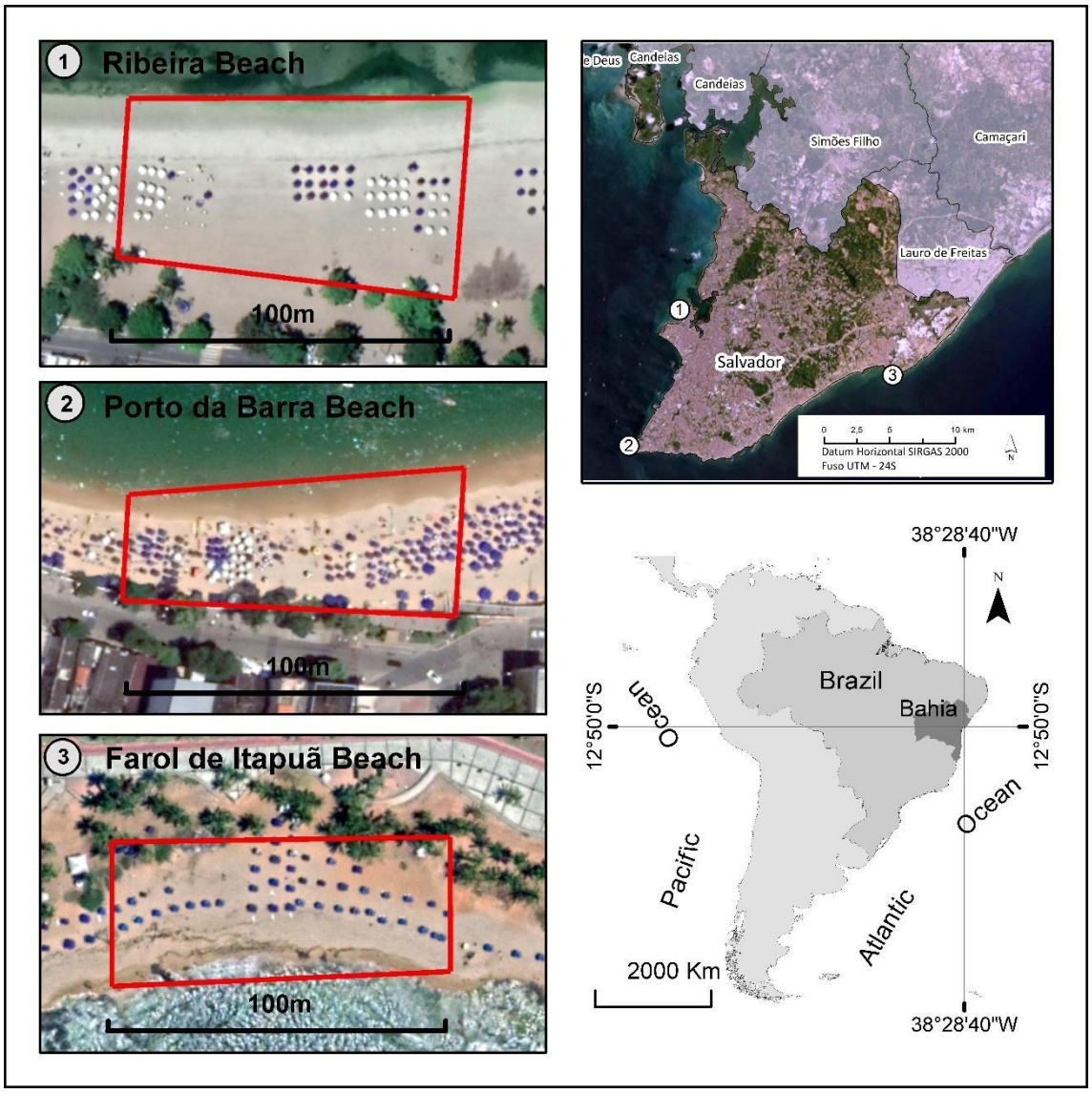

Figure 2. Location of the studied beaches along the Todos os Santos Bay (insert 1) and the Atlantic (inserts 2 and 3) shorelines, municipality of Salvador (highlighted in the upper right insert), state of Bahia, Brazil. Red polygons represent the sampled area in each beach (Source: Google Earth satellite images).

Table 1. Main natural and human-related characteristics of the studied beaches.

Beach	Site Coordinates	Location	Beach Type	Occupation on the Beachfront	User Profile	Beach Width (m)
Farol de Itapuã	12°57′20.85″ S 38°21′8.27″ W	Atlantic coast	Semi-exposed beach (outcrops)	Non-native vegetation, promenade, and street	Local district's population and tourists	41
Porto da Barra	13°00′11.28″ S 38°31′58.34″ W	Entrance of the Todos os Santos Bay	Semi-exposed beach (cove)	Promenade, street, bars, and restaurants	Central district's population and tourists	24

Ribeira	12°54′42.9″ S 38°29′ 51.34″ W	Todos os Santos Bay	Semi-exposed beach (within a bay)	Non-native vegetation, sidewalk, street with houses	Local and adjacent district population	43

Finally, the Ribeira beach is located within the Todos os Santos Bay. The region also holds high strong historical and cultural values. Its human occupation started taking place in the 19th century, during the onset of the industrialization period of the city, largely growing over the years. It represents one of the most degraded shoreline sectors in Salvador, both from urban and environmental perspectives. Ribeira beach is currently intensely used as a leisure area by the population of the Ribeira District and adjacent areas, characterized as low-income users, being considered a marginal region of the city (Figure 2).

2.2. Study Method and Data Analysis

The monitoring activities conducted in this study were authorized by the municipal management, even during the validity of the beach interdiction decrees, as they are part of a study started in February 2019 within the scope of the Projeto de Monitoramento dos Resíduos Sólidos em Praias Turísticas da América Latina—RSPT/LATAM (Solid Waste Management in Touristic Beaches in Latin America Project, in English), an initiative of the Red Iberoamericana de Gestión y Certificación de Playas—PROPLAYAS (Iberoamerican Beach Management and Certification Network, in English).

In view of an exceptional scenario starting on March 19, 2020, there was an opportunity to conduct a comparative study to confirm the expected trend and quantify the decreasing amount of litter on beaches during the period of restricted use by the population, correlating it with local litter production.

Marine litter quantification and classification were conducted every two months, in April, June, and August 2019 and 2020, coinciding with the low season period. These months were selected in order to compare beaches before and during the period when the local population and tourists were prohibited to use them due to the COVID-19 pandemic. Coping measures aimed at reducing the transmission of SARS-CoV-2, such as restricting access and prohibiting the use of touristic beaches by the population, were initially implemented in 19 March 2020 by the Municipal Decree No. 32,272 [33]. This was extended for the entire five-month interval (until 11 September 2020), within which the monitoring campaigns were conducted, through 12 additional successive decrees [38–49]. During this period, the main touristic beaches closed to the population included the three beaches monitored in this research. The aforementioned decree of the Municipality of Salvador even prohibited carrying out commercial activities on all of the listed beaches.

Field campaigns were always conducted during weekends, in the afternoon, when beaches were more intensely used [36], at a time that would not coincide with public beach cleaning which was conducted early in the morning and at the end of the day. Even during the period of beach closure, according to the public cleaning company responsible for it (Urban Cleaning Company of Salvador—LIMPURB), beach cleaning was also conducted twice a day, in the morning and in the afternoon [50]. However, in the monitoring campaigns conducted during the validity of the decrees that prohibited the use of beaches, the research team noticed some changes in the form and intensity of public cleaning operations, as it was observed that tractors were no longer used in the sand strip and the time of permanence of cleaning teams on the beaches was reduced. These logistical changes may have occurred due to a noticeable reduction in the amount of solid waste on the beach.

In each beach, marine litter was counted—but not collected—from 100 m-long transects, covering the entire subaerial beach width following the methodology proposed by Botero et al., (2021) [51] (Figure 2). In defining transect location, each selected beach was previously visited in order to identify points with the highest concentration of users. The

geographic coordinates of these points were obtained, and 50 m were measured to each side, following the length of the beach (parallel to the shoreline).

All identified litter was counted and divided into two classes: autochthonous litter and allochthonous litter. Items related to activities conducted on the beach itself were classified as autochthonous. They basically included items littered by tourism and leisure activities, including those that result from local commerce (i.e., kiosks, food, and drinks vendors). In turn, litter that apparently originated from other sources and sites, and were not discarded, disposed of, or abandoned by beach-related activities were classified as allochthonous. They encompassed items that presented characteristics that suggested transportation via ocean (bio-colonies, incrustations, signs of weathering and abrasion by waves, among others), and litter carried by rainfall runoff that ended up on the beaches via drainage system. Debris from other human activities conducted in the urban area adjacent to the beaches that were inappropriately discarded on them were also included in the study as allochthonous (i.e., house construction debris) (Figure 3).

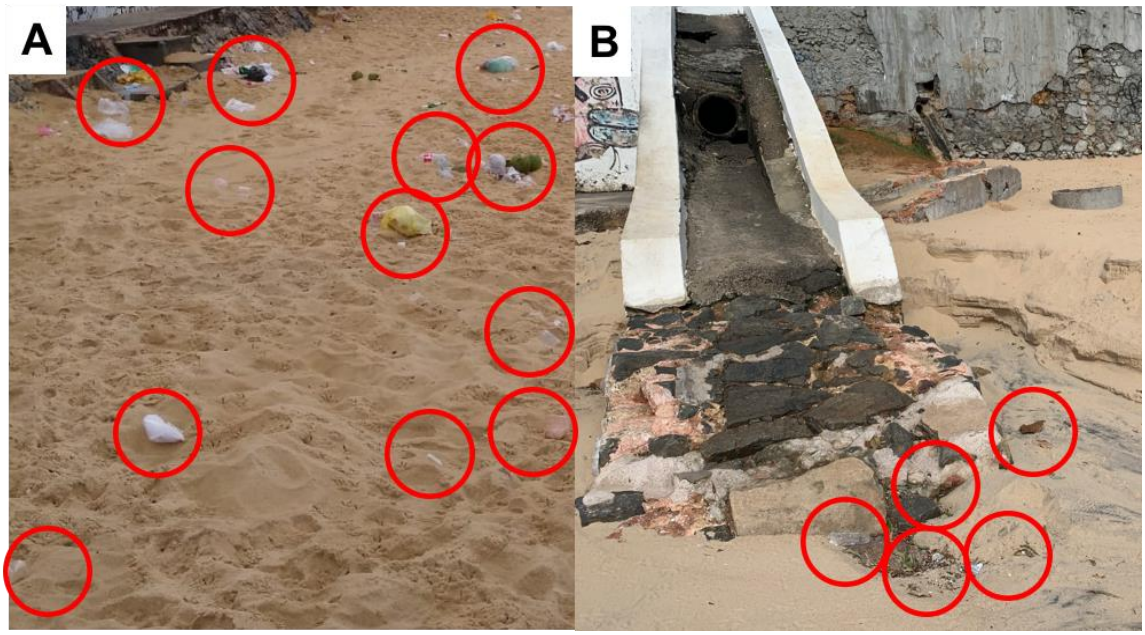

Figure 3. Porto da Barra beach. Examples of: (**A**) Autochthonous litter deliberately left in the sand; (**B**) Allochthonous litter brought by rainfall-runoff pipe.

All three beaches studied were classified, before and during the pandemic, according to their quality. In this case, beach quality referred exclusively to the presence (or absence) of marine litter, and the Clean-Coast Index (CCI) was used for this purpose [52]. The CCI is a beach classification method that uses the number of plastic items per area multiplied by a coefficient K = 20, therefore classifying them according to the following intervals: very clean (0–2); clean (2–5); moderate (5–10); dirty (10–20); extremely dirty (20+).

For the purposes of the present study, not only plastic items but all marine litter was used for calculating the CCI. This adapted version of the methodology has already been successfully reported in the literature (i.e., [11,13]).

2.3. Statistical Analysis

The data obtained were tabulated to quantify the amount of litter collected over 100 m stretches in each of the three beaches over the different sampling months and years. A descriptive analysis was conducted to quantify, in percentages, the difference in the number of marine litter items found in the selected beaches between 2019 and 2020, before and during the beach closure measure adopted during COVID-19 pandemic, for variables "beach" and "type of litter". A two-way mixed analysis of variance (ANOVA) test was

then conducted to investigate the impact of beach (Ribeira, Porto da Barra, and Farol de Itapuã), year (2019 and 2020), and type of litter (autochthonous and allochthonous) on marine litter quantity. Finally, a Chi-square test of homogeneity was used to evaluate whether the proportions of autochthonous and allochthonous litter items remained the same between pre- and during beach closure periods. $p < 0.05$ was considered as statistically significant. The software IBM SPSS (Statistics for Windows, Version 24.0, IBM Corp., Armonk, NY, USA) was used for conducting the statistical analysis.

3. Results

A total of 5395 items were sampled. From this total, 3583 items (66.41%) were sampled during the pre-beach closure months (April, June, and August 2019) and the remaining 1812 items (33.59%), during the beach access restriction period (April, June, and August 2020). The highest (pre-beach closure) and lowest (during beach closure) 3-month average values were observed for Porto da Barra beach, 472 and 82 items, respectively (Table 2).

Table 2. Amount, in number of items/100-m stretch, of total marine litter items—autochthonous and allochthonous—found during the sampled months; monthly average values for the pre-beach closure (2019) and during beach closure (2020) periods; and variation of these average values (also in percentage).

Beach	Type of Marine Litter Source	Number of Items/100-m Stretch before Beach Closure (2019)				Number of Items/100-m Stretch during Beach Closure (2020)				Difference in 3-Month Average Marine Litter, in Number of Items (%)
		April	June	August	3-Month Average	April	June	August	3-Month Average	
Farol de Itapuã	Autochthonous	398	284	284	322	154	259	285	233	**−89 (−28%)**
	Allochthonous	87	44	42	58	69	11	19	33	**−25 (−43%)**
	Total	485	328	326	380	223	270	304	266	**−114 (−30%)**
Porto da Barra	Autochthonous	457	600	256	438	52	53	53	53	**−385 (−88%)**
	Allochthonous	16	68	18	34	25	57	5	29	**−5 (−15%)**
	Total	473	668	274	472	77	110	58	82	**−390 (−83%)**
Ribeira	Autochthonous	200	169	439	269	360	154	103	206	**−64 (−24%)**
	Allochthonous	37	38	146	74	57	71	25	51	**−23 (−31%)**
	Total	237	207	585	343	417	225	128	257	**−86 (−25%)**

The subtypes of litter found varied substantially. However, those related to smoking, and drinks and food consumption predominated.

Statistical results showed no significant variation between beaches regarding the amount of litter ($F(2, 6) = 0.25$, $p = 0.78$). However, there was a significant influence of period (pre- versus during beach closure) on the amount of litter found ($F(1, 6) = 6.72$, $p = 0.04$), where the amount of litter sampled in 2020 was significantly lower than in 2019 (Table 2). Increase in litter was found between pre- and during beach closure periods in some months and in some of the beaches studied (e.g., number of allochthonous litter items in April in Praia da Barra beach, and April and June in Ribeira beach, autochthonous

litter source items in April in Ribeira beach), probably because allochthonous litter source disposal should be less affected by beach closure and Ribeira beach is, in general, less visited by tourists. However, as a whole, a significant decrease in litter was found between pre- and during beach closure.

In all beaches, both before and during the pandemic, the amount of autochthonous litter items was significantly higher than the allochthonous ones ($F(1, 6) = 129.76$, $p = 0.00$). Additionally, there was a significant interaction between year and type of litter ($F(1, 6) = 8.64$, $p = 0.03$), showing that litter reduction between years was much higher within the autochthonous class than within the allochthonous one.

The most important reduction in the amount of autochthonous litter (88%) was observed in Porto da Barra beach (Table 2), also reflected in the significant change of relative distribution between autochthonous and allochthonous litter in this beach between years ($X^2(1, N = 1660) = 165.80$, $p = 0.00$). This pattern was not observed in the other beaches, where the relationship barely changed despite the pandemic ($X^2(1, N = 1936) = 2.97$, $p = 0.09$ for Farol de Itapuã beach, and $X^2(1, N = 1799) = 0.69$, $p = 0.41$ for Ribeira beach) (Figure 4).

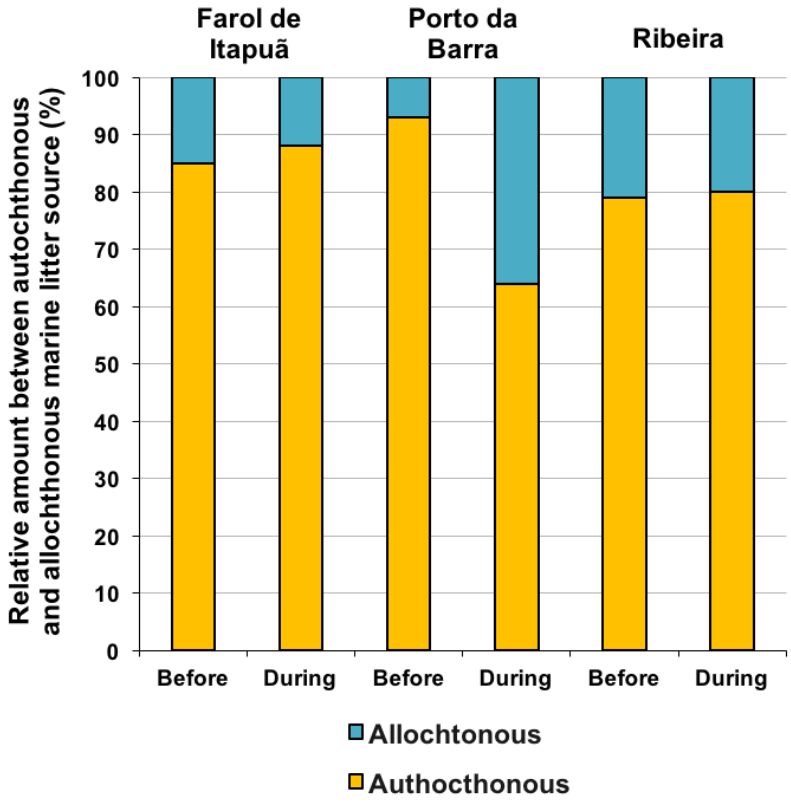

Figure 4. Relative amount of autochthonous and allochthonous litter before and during beach closure that occurred during COVID-19 pandemic.

Accordingly, the largest surveillance and control apparatus used to restrict access to the beach, including the installation of physical barriers, was observed at Porto da Barra beach, resulting in greater reduction of its use by the population compared to other beaches (Figure 5).

Figure 5. Overview of Porto da Barra beach showing: (**A**) wooden boards/barriers, blocking beach access; (**B**) presence of unauthorized users; (**C**) outlet of rainfall runoff.

There was a reduction in marine litter density between before and during beach closure periods, as the number of items per 100-m beach stretch decreased (Table 2). However, change in CCI did not result in major changes in beach classification (Table 3). Only Porto da Barra beach presented an increase in beach quality, improving from "clean" to "very clean". Farol de Itapuã and Ribeira beaches, although presenting a significant reduction in the pollution level, remained within the "very clean" classification (Table 3).

Table 3. Density of pollution by marine litter and classification according to the Clean-Coast Index (CCI) of the studied beaches before and during the beach closure measure taken due to the COVID-19 pandemic.

Beach	Density of Marine Litter (Number of Items/m²)	CCI Index (Considering Both Types of Litter)	Beach Classification ([49])
Before beach closure (2019)			
Farol de Itapuã	0.09	1.85	very clean
Porto da Barra	0.12	2.30	clean
Ribeira	0.08	1.67	very clean
During beach closure (2020)			
Farol de Itapuã	0.06	1.30	very clean
Porto da Barra	0.02	0.40	very clean
Ribeira	0.06	1.25	very clean

4. Discussion

The results of the present study allowed to characterize the amount and source of marine litter found on urban touristic beaches before and during beach closure, one of the measures adopted by local authorities in response to the COVID-19 pandemic.

Due to the intrinsic characteristics of the study area, which results in an intense use throughout the year—including during the low tourist season –, the amount of litter between all three beaches did not present significant differences. However, when data from before beach closure were compared with data from the period during which the measure was in effect, a significant reduction in the total amount of litter could be observed (Table 2). This pattern was also found in previous studies [21–23]. Such a result was expected because several activities, especially those conducted in public spaces, were reduced during the pandemic.

Regarding the source of the litter found in all three beaches studied, the autochthonous type predominated over the allochthonous one (>80%), except for the Porto da Barra beach during the pandemic (allochthonous = 64%) (Figure 4). This beach presented the most significant reduction in the amount of autochthonous litter (Table 2) and the most significant change in the relative proportion between autochthonous and allochthonous litter comparing the beach closure period and the pre-beach closure one. This can be explained not only by the fact that Porto da Barra beach is visited by tourists from other municipalities and that tourism activities have strongly been reduced, but also by the fact that a better effectiveness of the enforcement of the municipal decree was observed at this beach (presence of balustrade that could be closed), possibly because it is more centrally located and has a stronger touristic appeal compared with the other beaches.

This result confirms that local users are the most representative contributors to the generation of litter in these beaches. Similar results were also found in another study for the same beaches, where tourism and recreational activities were responsible for most of the beach litter found [13]. This predominance is not exclusive to Salvador. In fact, several studies, from other regions of the world, show that the litter found in the beaches with high rates of visitors consists mostly of products discarded from recreational activities conducted in such environments [10,53]. In these beaches, litter is mainly discarded in the surroundings of tents and kiosks or beach vendors, where food and drinks are sold and consumed [11–13].

Among the types of litter studied, autochthonous litter was the one that presented the most significant reduction (Table 2). However, allochthonous litter also presented a reduction—although in a lower proportion—during the beach closure in all three studied beaches. This result reflects a positive effect of the Municipal Decree No. 32.272 that prohibited beach access [33]. However, this decree did not prohibit the circulation of people in the public spaces adjacent to the beach. Though this circulation is likely to have decreased given the general circumstances, it still was able to contribute to the amount of allochthonous litter found, along other contributing factors such as coastal currents, rainfall runoff, and wind.

Regarding the beaches studied, the low occupation of public spaces not only allowed for the reduction of marine litter but also for the improvement of the ecosystem as a whole. Another study, which included all three beaches evaluated in the present study, showed that the lockdown period due to the COVID-19 pandemic allowed the beach ecosystem to partially recover, by increasing biodiversity and system functionality [23].

The "without user" situation cannot be considered as a tangible perspective for the post-pandemic period. However, the results obtained in the present study show that simple policies, such as incentives to increase marine litter awareness of users and workers, can potentially reduce the amount of litter in beaches by up to 83%. This is a significant reduction that might be achievable by an effective increase in awareness and by changing the habits of beach users.

Considering that observed objects and facts can lead to the association of ideas that stimulate certain actions, a perception of a better environmental reality provided by the

pandemic, when associated with environmental education actions, can be valuable in changing people's attitude [54]. As reinforced in the literature, environmental education represents an important tool, supplying users with the necessary knowledge for engagement and changes in habits [37,55]. Accordingly, activities regarding health education and prevention of vector diseases may raise awareness among beach users by emphasizing the correlation between transmission cycles and inadequate disposal of solid waste.

Therefore, during the post-pandemic period, simple waste management practices combined with educational actions, if implemented in beaches with similar characteristics to the ones presented in this study, may potentially stimulate positive habits, thus reducing the generation of beach litter.

Study Limitations

Regardless of the access restrictions, autochthonous litter could be found in Porto da Barra beach during the pandemic. This fact highlights a few limitations of the methodology used in the present study, such as: (i) It is not always easy to tell the difference between the litter discarded, disposed, or abandoned by beach users and what comes from other sources, brought from adjacent areas. This is particularly more relevant when adjacent beaches have similar uses. Thus, typical beach activities in Porto da Barra beach, such as the consumption of food and drinks, extend to the promenade and areas surrounding the beach; (ii) often, litter from previous campaigns fail to be removed by public cleaning agents and can be recounted during the following month, particularly for small items such as cigarette butts and straws. This limitation of the current cleaning method used in Salvador's beaches has been previously addressed by other authors [13,31]. All litter items were only counted, not extracted from the beach; and (iii) finally, in many situations, buried litter can be counted later, after sand remobilization.

Before the pandemic, litter density categorized the studied beaches as very clean (Farol de Itapuã and Ribeira) and clean (Porto da Barra) (Table 3). However, the fact that the beaches were in the cleaner side of the CCI spectrum, does not mean that they were free of litter. It is important to highlight that the CCI classification for a "very clean" beach means no litter can be seen, while for a "clean" beach it means no litter is seen over a large area [52]. The fact that litter cannot be seen from afar does not mean it is not present, as the results of this study showed. This is particularly true for meso and microlitter.

Although precautions have been taken, the results of the present study may have also been influenced by public cleaning, which is conducted twice a day. Three years prior to this study, another study, which also evaluated marine litter pollution of beaches along the Atlantic coast and the Todos os Santos Bay, classified some beaches as dirty and extremely dirty according to the CCI, reflecting that the cleaning methods used by the municipality were not efficient [13]. In contrast to the results presented here, although the authors from that study classified Farol de Itapuã also as clean during low and high seasons, their results indicated that the Ribeira and Porto da Barra beaches were extremely dirty during both seasons. This difference may be the result of changes in public cleaning policies, not registered previously in the literature but observed by the authors of this study, as they have been monitoring the same beaches over the course of approximately 10 years and some of them participated in the study mentioned above.

Despite the limitations of this study methodology, the effectiveness of the enforcement of the decree prohibiting the use of the Porto da Barra beach during the pandemic allows us to use it as an example of a successful case of a beach that, during the pandemic, was free from users and therefore we could compare the amount of litter in a beach with users (before the pandemic) and without users (during the pandemic). The quality, regarding the presence or absence of litter in the Porto da Barra beach increased from clean, before the pandemic, to very clean during the pandemic.

5. Conclusions

The COVID-19 pandemic provided a once-in-a-lifetime opportunity to have a natural in situ laboratory for the study of urban beaches free from users. This important variable cannot be easily removed from the equation during regular periods. The present study performed a characterization of the amount and source of the litter found on beaches of the municipality of Salvador before and during beach closure occurred during the COVID-19 pandemic. Prohibited beach use and reduced circulation in public spaces produced a decrease of up to 83% in the total amount of litter on the beaches studied. Most of the litter found was autochthonous, i.e., associated with recreational use and consumption activities that take place on the beach itself. The results from this study can be an important argument to stimulate actions that would raise awareness of the population regarding this urgent environmental issue. The pandemic experience may be used to increase public perception regarding environmental issues directly caused by beach users and can be an important catalyst, if associated with environmental education practices, for changes in habits to guarantee a cleaner beach.

Supplementary Materials: The supplementary materials can be downloaded at: https://www.mdpi.com/article/10.3390/su15032009/s1.

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Beach	Type of marine litter	2019 April	2019 June	2019 August	2019 monthly average
Farol de Itapuã	autochthonous marine litter	398	284	284	322
	allochthonous marine litter	87	44	42	58
	total marine litter	485	328	326	380
Porto da Barra	autochthonous marine litter	457	600	256	438
	allochthonous marine litter	16	68	18	34
	total marine litter	473	668	274	472
Ribeira	autochthonous marine litter	200	169	439	269
	allochthonous marine litter	37	38	146	74
	total marine litter	237	207	585	343

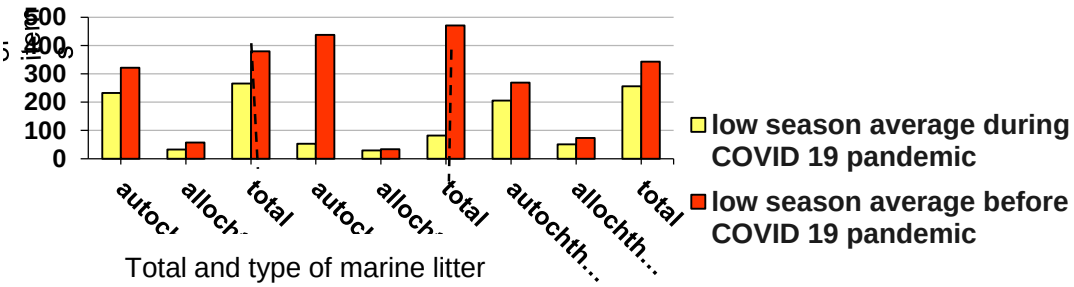
		2019 low season	2020 low
Farol de Itapuã	autochthonous	322	233
	allochthonous	58	33
	total	380	266
Porto da Barra	autochthonous	438	53
	allochthonous	34	29
	total	472	82
Ribeira	autochthonous	269	206
	allochthonous	74	51
	total	343	257

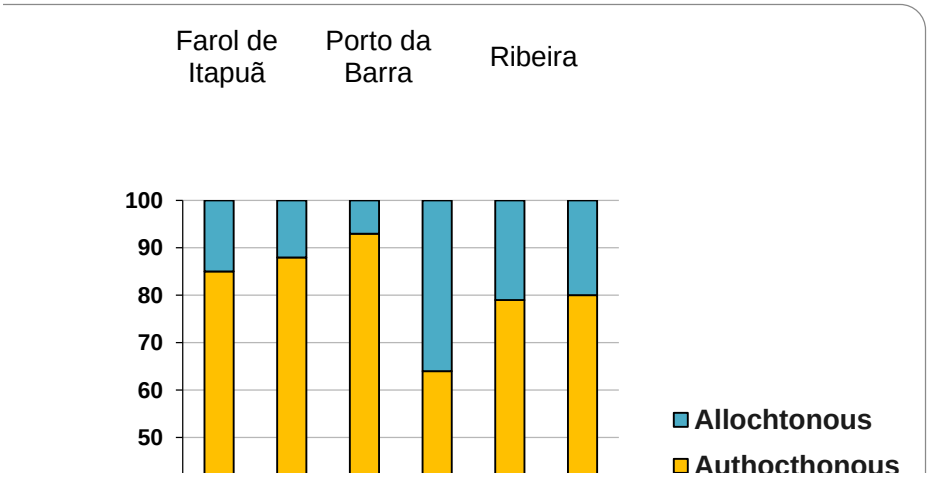
Num ber of

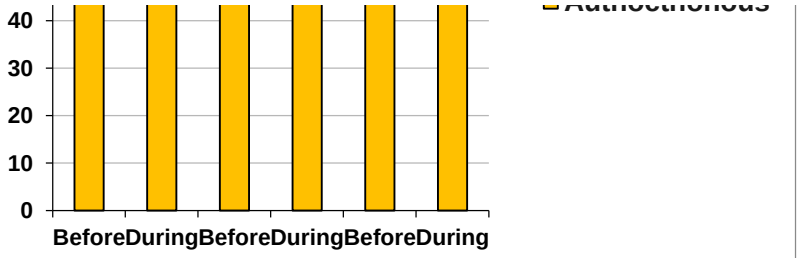
		2019 low season	2020 low
Farol de	autochthonous	85	88
	allochthonous	15	12
Porto da	autochthonous	93	64
	allochthonous	7	36
Ribeira	autochthonous	79	80
	allochthonous	21	20

	Period relative to COVID-19 pandemic	Autochthonous	Allochthonous
Farol de Ita	Before	85	15
Farol de Ita	During	88	12
Porto da	Before	93	7
Porto da	During	64	36
Ribeira	Before	79	21
Ribeira	During	80	20

2019 monthly average (%)	2020 April	2020 June	2020 August	2020 monthly average	2020 monthly average (%)	Variation in low season average between 2019 and 2002 (%)
85	154	259	285	233	88	-28
15	69	11	19	33	12	-43
100	223	270	304	266	100	-30
93	52	53	53	53	64	-88
7	25	57	5	29	36	-15
100	77	110	58	82	100	-83
79	360	154	103	206	80	-24
21	57	71	25	51	20	-31
100	417	225	128	257	100	-25



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