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Baseline

First inventory of marine debris on Alegranza, an uninhabited island in the Northeast Atlantic

Alicia Herrera[a,b,*], J. Alexis Rivera[c], Teresa Moreno[d], Ico Martínez[a], May Gómez[a]

[a] *Marine Ecophysiology Group (EOMAR), Iu-ECOAQUA, Universidad de Las Palmas de Gran Canaria, 35017 Campus Universitario de Tafira, Canary Islands, Spain*
[b] *Asociación para la Conservación Medioambiental Latitud Azul, Spain*
[c] *WWF España, Spain*
[d] *Instituto Politécnico de Formación Profesional Marítimo-Pesquero de Canarias, Spain*

A R T I C L E I N F O

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A B S T R A C T

Alegranza is the most northerly island of the Canary Islands archipelago, the first obstacle crossed by the Canary Current. From July to October 2020, six expeditions were led to the island to make a first inventory of marine debris and its possible source and origin. In total, 3667 objects weighing 321 kg were removed, excluding wooden objects. Of these, 97.7% were plastics, the most abundant being drink bottles (25.4%). While knowing the origin, source and pathway of debris is difficult, legible labels provided valuable information. In Alegranza, 66.7% of the legible bottle labels indicated Asian countries of manufacture, which is evidence that the source is maritime traffic in the region. The lobster trap license labels from the east coast of the United States and Canada were dated from 1999 to 2018, supporting both the exogenous origin and long lifetime in the ocean of these debris.

Plastic pollution in the oceans is one of the greatest global environmental problems (Barnes et al., 2009; Eriksen et al., 2014; Galgani et al., 2019). In 1950, plastic production crossed 2 million tons, while today it reaches almost 400 million tons per year. This excessive growth has not been accompanied by a capacity to manage the enormous amount of industrial waste generates, which means that 79% of the plastic waste produced still remains in the environment (Geyer et al., 2017). Recent estimations indicate that even considering ambitious agreements to reduce plastic pollution, 53 million tons per year may enter the ocean by 2030 (Borrelle et al., 2020).

The Canary Islands extend off the northwest coast of Africa, disturbing both currents and surface winds, the prevailing winds are the north-easterly trade winds, more intense during summer, and the permanent mean current is the southwestward Canary Current (Sangrà et al., 2005). Due to its geographical location, it is a hot spot of marine litter accumulation, since all the debris carried by the Canary Current deposits on its northeast-facing coast (Baztan et al., 2014; Herrera et al., 2018; Reinold et al., 2020).

The Canary Current is the extension of the Azores Current a descendent brand from the Gulf Stream. It approaches the eastern margin of the North Atlantic and turns southwards, driven by winds and by the limitation of the African coast (Machín et al., 2006). This southward flow is composed by the upper-thermocline of the North Atlantic Central Waters (NACW), and takes place in the upper 700 m c.a. of the Canary basin, approximately between the Strait of Gibraltar (36°N) and Cape Blanco (21°N) and from the African mainland to 20°W. It is also fed by the anticyclonic recirculation south of the North Atlantic Current (and north of the Azores Current), particularly by the southward flowing Portugal Current off the Iberian Peninsula, however this is only evident during summer and autumn (Machín et al., 2006).

Alegranza is the northernmost island of the Canary Islands, and therefore the first to be encountered by the Canary Current. It is a volcanic island of 10.2 km^2, part of the Chinijo Archipelago, with a maximum altitude of 289 m. at La Caldera volcano. The archipelago is protected by the figure of the Natural Park of the Chinijo Archipelago and has also been recognised as a special protection area for birds (ZEPA), has an exceptional environmental value and is the largest marine reserve in Europe with 700 km^2. The breeding populations of Cory's shearwater in the Chinijo Archipelago represent more than 10% of all the populations in the Macaronesian region; more than 10,000 pairs breed in Alegranza (Martín and Nogales, 1993; Rodríguez et al., 2003). Alegranza has been uninhabited since 1968 and receives very few

* Corresponding author at: Marine Ecophysiology Group (EOMAR), Iu-ECOAQUA, Universidad de Las Palmas de Gran Canaria, 35017 Campus Universitario de Tafira, Canary Islands, Spain.
E-mail address: alicia.herrera@ulpgc.es (A. Herrera).

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Fig. 1. Marine debris accumulated in Caleta del Trillo, Alegranza. July 17, 2020. Photo Jorge Cáceres.

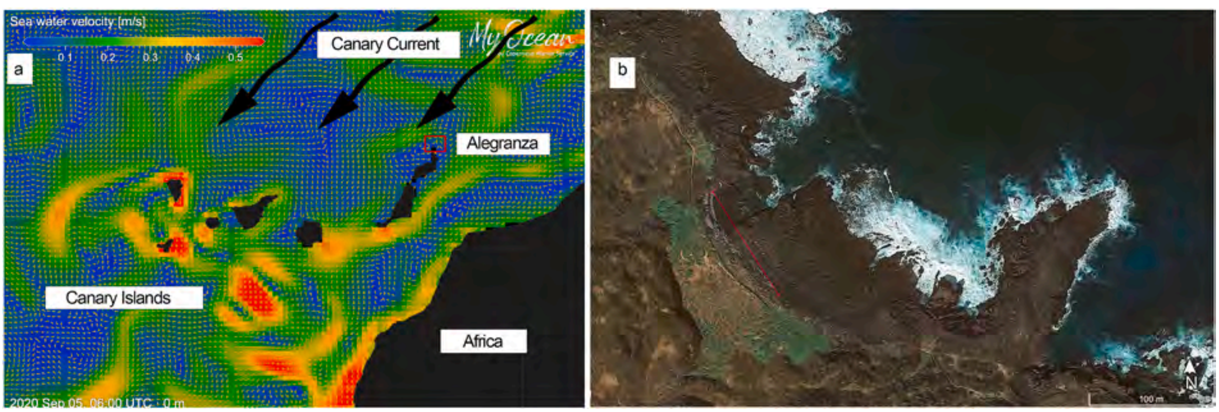

Fig. 2. a) Map of the Canary Islands showing sea water velocitiy (m/s) on September 5th 2020. Red square indicating sampling area (Alegranza island) black arrow indicating Canary Current. Image generated using E.U. Copernicus Marine Service Information. b) Caleta del Trillo (Alegranza island). Red line indicates the 100-m sampling transect in Caleta del Trillo (Alegranza Island). Image provided by Google Earth. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

visitors, mainly scientists, as access is forbidden and requires permits. It is, therefore, a place of particular interest to study the arrival of marine debris from the ocean and its possible effect on the environment and the animals inhabiting it, especially birds.

The Canary Islands are an area particularly vulnerable to plastic pollution, as the ocean currents transports marine litter from the east coast of the United States and Canada, North Africa and Europe to its shores (Maximenko et al., 2012; van Sebille, 2014; van Sebille et al., 2012). See the web https://plasticadrift.org to explore the probable trajectory and destination of floating debris, based on statistical model of the surface pathways of the oceans (van Sebille, 2014; van Sebille et al., 2012).

The Ministry of Ecological Transition and Demographic Challenge (MITECO) in Spain monitors marine litter at different points along the Spanish coast (Gil Gamundi and Martínez-Gil Pardo de Vera, 2018, 2020). In monitoring marine litter, knowing the possible source and pathway is essential. In many cases, locating the source is difficult, because many items cannot be identified, such as plastic fragments, or in other cases may have multiple sources such as plastic bottles discarded on beaches by users, arriving via rivers or dumped into the sea from ships (Veiga et al., 2016).

According to the data obtained by MITECO (Gil Gamundi and Martínez-Gil Pardo de Vera, 2020), in the Canary Islands demarcation, which includes 2 beaches, Janubio (Lanzarote Island) and El Socorro (Tenerife Island), the possible source of the marine litter was 24.5% wastewater, 13.8% fishing, 14.5% other (land), 13.2% tourism, 9.4% shipping, 8% hotel and commerce, 6.8% construction, 6% aquaculture, 2.9% other (sea), and 0.96% agriculture.

It should be noted that both beaches are frequented and, unlike Alegranza, receive a contribution of debris both locally and through the Canary Current. Since 2001, WWF (World Wildlife Fund) Spain has launched clean-up campaigns in which more than 30 tons of plastic and other marine debris have been removed from the Chinijo Archipelago. In Alegranza, the last clean-up was conducted in June 2018 by WWF volunteers.

In this context, the Canary Islands appear as a region particularly exposed to marine litter, with serious consequences for biodiversity and marine ecosystems (Herrera et al., 2019, 2020; Rodríguez et al., 2012). On July 17, 2020, on a scientific expedition to Alegranza, this fact was evidenced by the amount of garbage accumulated in Caleta del Trillo, located on the coast exposed to the northeast (Figs. 1 and 2).

The study focused on Caleta del Trillo, a coastline approximately

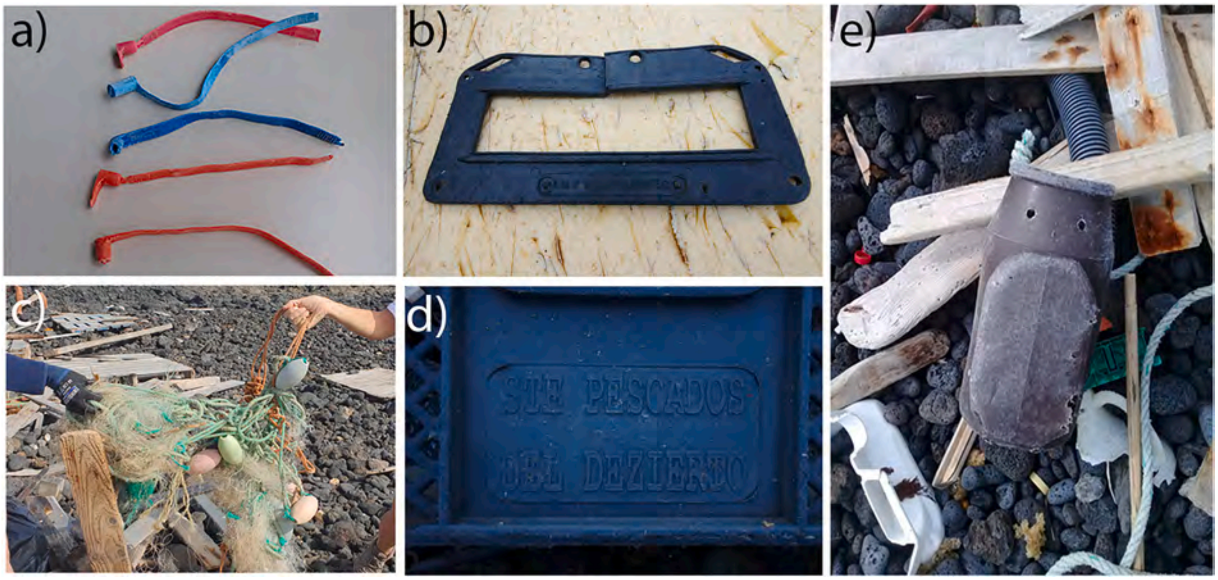

Fig. 3. Different types of marine litter from maritime traffic, fishing and aquaculture. (a) Lobster-pot tags (b) Pot door. (c) Nets, ropes and buoys. (d) Fish boxes. (e) Octopus traps.

100 m long, which accumulates much of the marine debris on the island, due to its orientation, which exposes it to the prevailing winds and currents (Fig. 2b). A first visual inspection was carried out on July 17, 2020, followed by five clean-ups in which all items larger than 5 cm were classified, on September 5, 6, 7 and 12, and October 16, 2020. The clean-up focused on plastic objects, textiles, metals and sanitary material; no wood or pallets were removed.

The sampling methodology proposed in the OSPAR protocol (OSPAR, 2010) was followed, choosing the 100-m sampling units to identify all marine debris items. According to the OSPAR protocol, a sampling unit is a fixed section of the beach spanning the entire area between the water's edge and the back of the beach (OSPAR, 2010). The same 100-m sampling unit were analyzed in each cleaning, until at the end of the 5th sampling day it was almost completely clean of plastic and metallic objects larger than 5 cm. The objective is to survey once a year in the same area to estimate the annual contribution of marine litter and analyze the trend in each litter category studied.

Marine litter classification was according with the guidelines from OSPAR (2010), UNEP/IOC (Cheshire et al., 2009) and European Commission TSG_ML group (MSFD Technical Subgroup on Marine Litter, 2013). In Alegranza we did not have permission to stay overnight, and due to the difficulties to ashore depending on the tides, most of the clean-ups had to be done in 2 or 3 h. In order to classify and clean as much debris as possible, only items larger than 5 cm was removed, the categories are detailed in Table S1. For logistical reasons, the weighing of the material was carried out in 3 large groups into which the litter was separated, 1- Material derived from maritime traffic, fishing, and aquaculture; 2- Daily use plastic (without PET bottles); 3- Drink bottles (PET bottles).

All results of quantity or density are expressed in 100-m units according to the OSPAR protocol (OSPAR, 2010).

Objects with legible labels were photographed to determine their

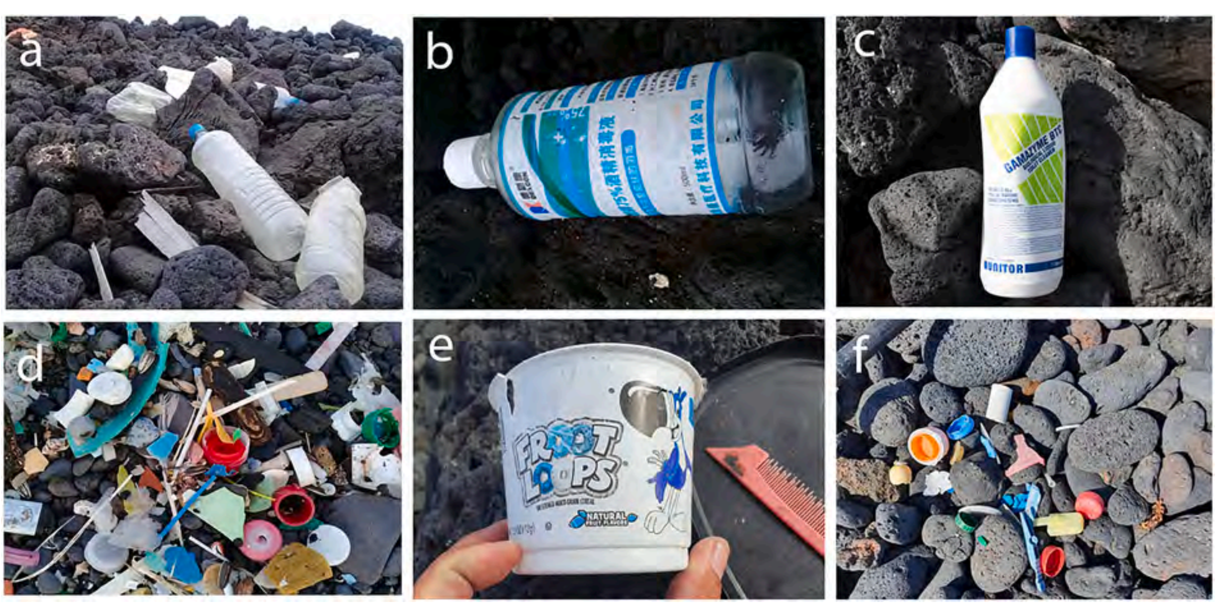

Fig. 4. Different types of daily-use plastics. (a) Drink bottles (PET bottles). (b) Bottle with label. (c) Cleaning-product container. (d) Fragments, swabs and caps. (e) Cereal container and comb. (f) Clothespins, felt-tip pen caps, fragments, and caps.

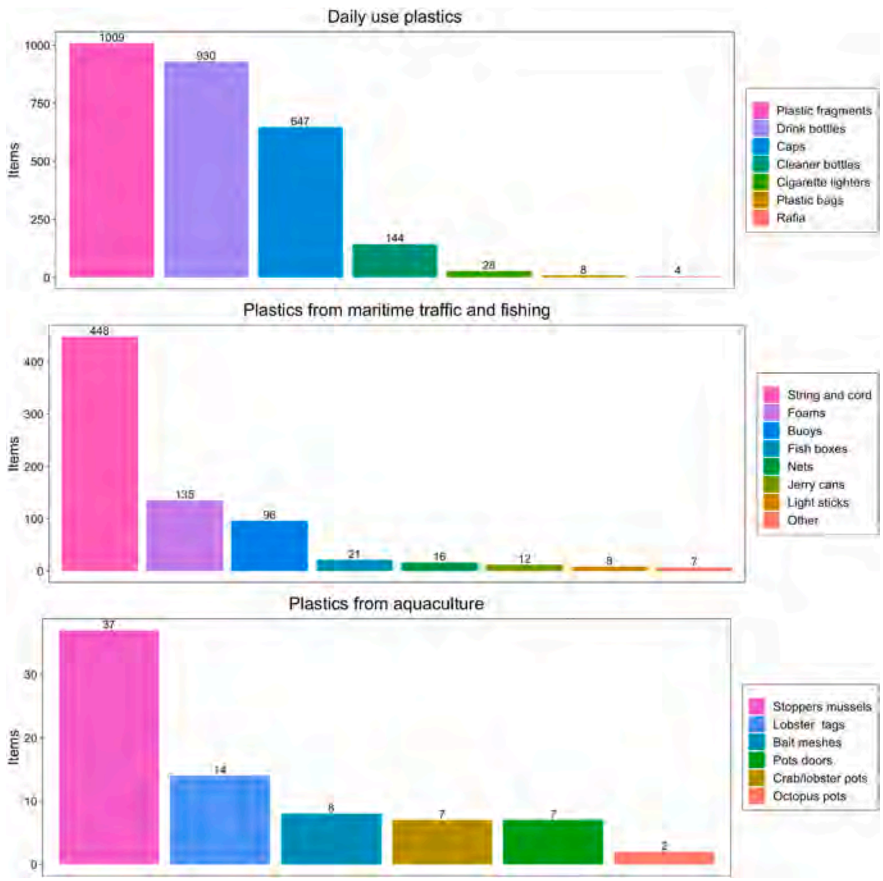

Fig. 5. Main types of plastic within each group removed from Alegranza in 100-m sampling units according to OSPAR protocol (OSPAR, 2010). Note: Plastic fragments have been included in everyday products group, although their origin is unknown.

possible source, geographical origin, and pathway. Here we use the term "source" to refer to the economic sector or human activity from which the litter originates, and the term "pathway" to refer the route through which the litter reaches the marine environment (Veiga et al., 2016). For example, plastic bottles could have several sources (beach users, consumers/general public or fisheries) and the pathway could be direct input from the beach, rivers or from ships. Thus, in case of visible label, the possible source, pathway, and geographical origin could be identified. In Alegranza, labels from Asia are unlikely to be borne by currents; therefore, we deduce that the source is maritime traffic/fishing, the pathway is direct input, and the geographic origin is the country of manufacture.

No paper or cardboard waste was found, probably due to degradation, nor cigarette butts or objects from tourism. Since most of the marine debris was plastic, the predominant types were classified, and their possible origin analyzed (Figs. 3 and 4).

A total of 3667 items with a weight of 321 kg were removed, of which 97.7% were plastic, 1.9% textile and 0.4% metal, and no paper or

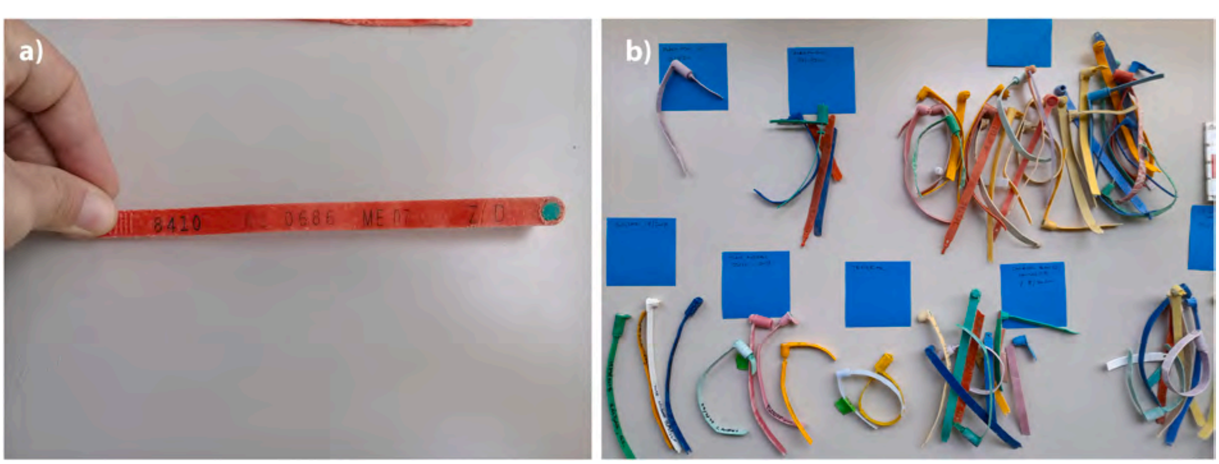

Fig. 6. a) Lobster-pot 2007 license tag from the coast of Maine, USA (ME 07). b) Lobster-pot labels from the east coast of the United States and Canada found on the coasts of the Canary Islands thanks to the collaboration of volunteers in a citizen science program of the MICROTROFIC project (University of Las Palmas de Gran Canaria).

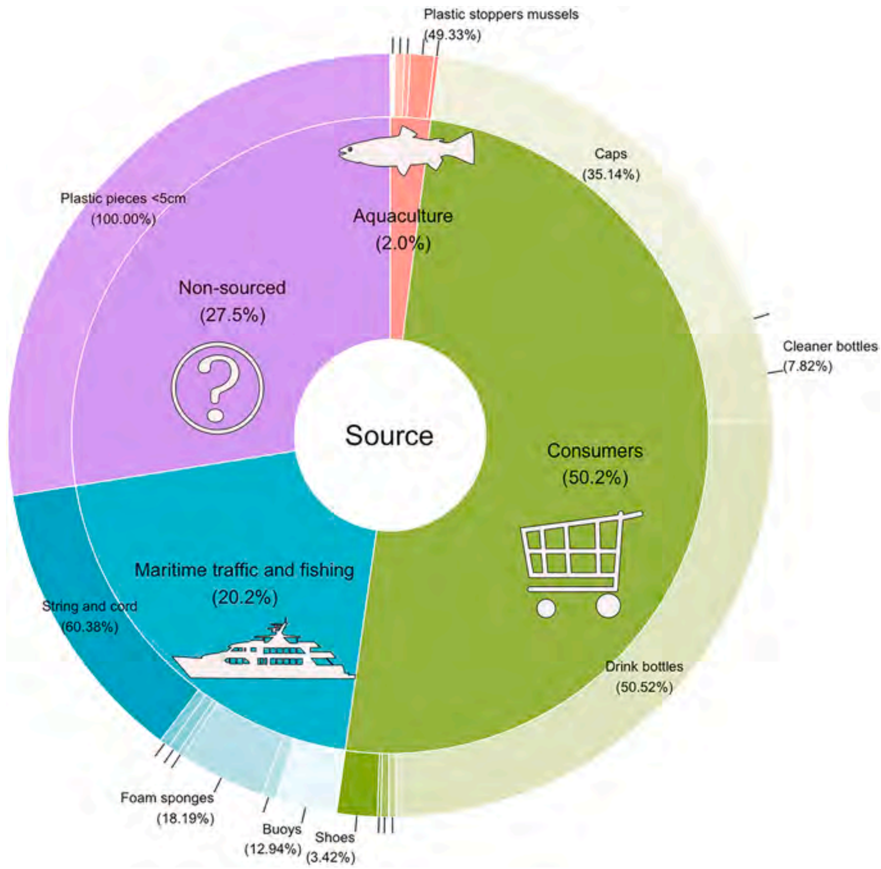

Fig. 7. Inner pie chart: possible source of the items found (in percentage). Outer donut chart: percentage of items within each group.

cardboard objects were recovered. Most of the objects removed were plastic, so the type of plastic object, possible origin and sources were analyzed. The most abundant everyday plastic objects were PET bottles, plastic fragments, and caps (Fig. 5).

A remarkable fact is the enormous quantity of drink bottles arriving at Alegranza, both from maritime traffic and of unknown origin, accounting for 25.4% of the items found. Similar results were obtained by Morales-Caselles et al. (2021), in this review, plastic bottles were in the top five global litter in all environments and representing 12.9% of the items found on the shoreline. Based on these results, a fundamental objective in the fight against marine litter being to reduce the consumption of plastic drink bottles.

Among the plastics derived from maritime traffic, the abundance of ropes and buoys stands out; while among the objects derived from aquaculture, the presence of sticks from mussel farming ropes and lobster-pot labels from the east coast of the United States and Canada predominate (Figs. 5 and 6).

Regarding the possible sources, 50.2% corresponds to consumers/general public with an unknown pathway, 20.2% comes from maritime traffic and fishing, 2% comes from aquaculture-related activities, while 27.6% are fragments from unknown sources (Fig. 7).

The percentages in weight vary given the characteristics of the objects, as drink bottles are lighter and plastics derived from fishing such as nets, ropes and buoys are larger and heavier objects. By weight, of the 321 kg removed, 202 kg corresponded to maritime traffic and aquaculture (62.9%), 97.4 kg to daily-use plastic (30.3%) and 21.7 kg were drink bottles only (6.7%).

Regarding the identified sources and pathways, a large percentage of waste springs from maritime traffic and fishing activity (20.2%). This is very relevant, as global maritime traffic has grown considerably in the last 30 years and is projected to increase by 240 to 1209% by 2050 (Sardain et al., 2019), and may represent a very important source of marine litter, not only nets and fishing gear but also bottles, daily use plastics, and loss of cargo. A notably high percentage of water bottles had legible labels indicating Asian origin, but they have probably been dumped from ships in the North Atlantic. This fact was already confirmed in a previous study in the islands, which found that more than 40% of the microplastic samples on the Famara beach (Lanzarote Island) were resin pellets, a raw material for the manufacture of plastic objects. There are no plastic industries on the island and, therefore, these pellets have an exogenous origin, and reach the shores carried by the Canary Current (Herrera et al., 2018).

The lobster license tags provided us with important information on the geographic origin, pathway, and sources, as well as the date entered the ocean. Most of the labels come from Maine and Massachusetts coasts, and from the east coast of Canada. They all come from aquaculture in this region and have been washed up on the Canary coast by the Canary Current. Regarding the date, licenses have been found from 1999 to 2018, this data shows that there are plastics that may have been in the sea for more than 20 years and are still in good condition and with legible labels.

The analysis of the legible labels, predominantly from plastic bottles, showed that 66.7% were products manufactured in Asian countries, 9.5% were from Spain, 19.1% from other European countries and 4.8% from Africa. This data indicates the geographic origin of these debris, and in the case of bottles from Asian countries, despite being products of daily use, they have probably entered the sea via maritime traffic, so their possible source is maritime and fishing activity. This data may also lead to confusion regarding the geographic origin of the debris, since it is probable that the bottles dumped from ships in closer areas reach the coast earlier and therefore still have legible labels, while those that entered the sea from the coast (for example the East coast of the United States and Canada) have been floating in the sea for a longer time and therefore have lost their labels or are not legible.

Fig. 8. Cory's shearwater (*Calonectris diomedea*) carcass trapped on a rope, Caleta del Trillo, Alegranza, October 2020. Photo: Jorge Cáceres.

It is a big challenge to determine the source, the origin and pathway in other debris; being Alegranza an uninhabited island, and being the northernmost, the origin will be exogenous, however they may come from different activities (tourism, industry, fishing), have been entering from land or sea, and their geographical origin could be diverse even if they have labels in Spanish or English, as they could be products sold in different regions.

Results from other macro-debris studies on islands are consistent with those reported for Alegranza Island in the present study. On Scottish Orkney Islands a mean of 533 items per 100 m was found, with a maximum of 5171 items per 100 m on Burray Island. Overall, plastic accounted for 77% of the debris, and 47% of the items came from the fishing sector, with cords and strings being the most abundant items (Buckingham et al., 2020). On Henderson Island, a remote, uninhabited island in the South Pacific, debris density was the highest reported globally, with maximum values of 671,6 items/m^2. The most frequently encountered items were fishing-related objects, caps and lids, and plastic bottles (Lavers and Bond, 2017). Similar to the Canary Islands in the North Atlantic, the Henderson Islands receive the debris transported by the currents, mainly from the subtropical gyre of the South Pacific, which explains the amount of debris coming from South America (23% of the identifiable items) (Lavers and Bond, 2017).

Moreover, recent study analyzing marine debris inventories data worldwide concludes that 83% found in shorelines are plastics, largest amount is from take-out food and beverage containers, followed by debris from fishing activities (Morales-Caselles et al., 2021).

One of the most devastating effects of plastic pollution is the damage to ecosystems and marine organisms. Abandoned or lost fishing nets, known as “ghost nets”, continue to drift, damaging and even killing several animals, including birds. Among the fishing waste found in this study, the large amount of ropes, remains of nets and buoys that pose a threat to birds stands out, as illustrated in the photograph from Alegranza of a dead Cory's shearwater entangled in a rope (Fig. 8).

Alegranza is home to birds catalogued as vulnerable or endangered, such as the osprey (*Pandion haliaetus*), the storm petrel (*Pelagodroma marina*), the Cory's shearwater (*Calonectris diomedea*) and Eleonora's falcon (*Falco eleonorae*). For birds, there is also the danger associated with ingestion, since they can ingest large pieces of plastic, which they will be unable to expel with their faeces due to their small cloacae. As their stomachs are full of plastic, they feel a false sense of satiety, leading them to die of starvation. On the other hand, recent studies indicate that many birds which are chemosensitive predators, including birds of the order Procellariiformes, such as shearwaters, are more vulnerable to plastic ingestion because they respond to the odour of dimethyl sulphide (DMS) (Savoca et al., 2016). In plastics that have been in the sea for some time, the process of biofouling occurs in which phytoplankton, especially diatoms and coccolithophorids, as well as bacteria, stick to their walls. These organisms emit DMS that acts as a chemical signal that attracts this type of birds, which in this way confuse the plastics with their food. In a study conducted in the Canary Islands, an average of eight pieces of plastic was found in the stomach of Cory's shearwater chicks (Rodríguez et al., 2012).

For the above reasons, we believe that it is crucial to continue with the clean-ups, and the study and classification of marine debris that arrives at Alegranza through the Canary Current to determine the changes that occur over time in the type of debris and its sources (Galgani et al., 2015). In this way, managers and policy makers will be able to evaluate the effectiveness of the applied environmental policies and define the new conservation policies to be implemented.

Supplementary data to this article can be found online at https://doi.org/10.1016/j.marpolbul.2022.113604.

CRediT authorship contribution statement

A.H. designed the experiment, collected the samples, analyzed the data, performed statistical analyzes and graphics with R, and wrote the original draft. A.R. and T.M. designed the experiment and collected the samples. All authors contributed to the acquisition of the data and edited the article.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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References

Barnes, D.K.A., Galgani, F., Thompson, R.C., Barlaz, M., 2009. Accumulation and fragmentation of plastic debris in global environments. Philos. Trans. R. Soc B 364, 1985–1998. https://doi.org/10.1098/rstb.2008.0205.

Baztan, J., Carrasco, A., Chouinard, O., Cleaud, M., Gabaldon, J.E., Huck, T., Jaffrès, L., Jorgensen, B., Miguelez, A., Paillard, C., Vanderlinden, J.P., 2014. Protected areas in the Atlantic facing the hazards of micro-plastic pollution: first diagnosis of three islands in the canary current. Mar. Pollut. Bull. 80, 302–311. https://doi.org/10.1016/j.marpolbul.2013.12.052.

Borrelle, S.B., Ringma, J., Law, K.L., Monnahan, C.C., Lebreton, L., Mcgivern, A., Murphy, E., Jambeck, J., Leonard, G.H., Hilleary, M.A., Eriksen, M., Possingham, H. P., de Frond, H., Gerber, L.R., Polidoro, B., Tahir, A., Bernard, M., Mallos, N., Barnes, M., Rochman, C.M., 2020. Predicted Growth in Plastic Waste Exceeds Efforts to Mitigate Plastic Pollution.

Buckingham, J., Capper, A., Bell, M., 2020. The missing sink - quantification, categorisation and sourcing of beached macro-debris in the scottish Orkney Islands. Mar. Pollut. Bull. 157 https://doi.org/10.1016/j.marpolbul.2020.111364.

Cheshire, Anthony, Adler, Ellik, Barbière, Julian, 2009. UNEP/IOC guidelines on survey and monitoring of marine litter. In: United Nations Environment Programme, Regional Seas Programme.

Eriksen, M., Lebreton, L.C.M., Carson, H.S., Thiel, M., Moore, C.J., Borerro, J.C., Galgani, F., Ryan, P.G., Reisser, J., 2014. Plastic pollution in the world's oceans: more than 5 trillion plastic pieces weighing over 250,000 tons afloat at sea. PLoS ONE 1–15. https://doi.org/10.1371/journal.pone.0111913.

Galgani, F., Hanke, G., Maes, T., 2015. Chapter 2 global distribution, composition and abundance of marine litter. In: Bergmann, M., Gutow, L., Klages, M. (Eds.), Marine Anthropogenic Litter. Springer International Publishing, p. 456. https://doi.org/10.1007/978-3-319-16510-3.

Galgani, L., Beiras, R., Galgani, F., Panti, C., Borja, A., 2019. Editorial: "impacts of marine litter". Front. Mar. Sci. 6, 4–7. https://doi.org/10.3389/fmars.2019.00208.

Geyer, R., Jambeck, J.R., Law, K.L., 2017. Production, use, and fate of all plastics ever made. Sci. Adv. 25–29.

Gil Gamundi, J.L., Martínez-Gil Pardo de Vera, M., 2018. Programa de Seguimiento de Basuras Marinas En Playas. Informe de Resultados 2013-2018.

Gil Gamundi, J.L., Martínez-Gil Pardo de Vera, M., 2020. Programa de Seguimiento de Basuras Marinas En Playas. Informe de Resultados 2020.

Herrera, A., Asensio, M., Martínez, I., Santana, A., Packard, T.T., Gómez, M., 2018. Microplastic and tar pollution on three Canary Islands beaches: an annual study. Mar. Pollut. Bull. 129, 494–502. https://doi.org/10.1016/j.marpolbul.2017.10.020.

Herrera, A., Stindlová, A., Martínez, I., Rapp, J., Romero-Kutzner, V., Samper, M.D., Montoto, T., Aguiar-González, B., Packard, T., Gómez, M., 2019. Microplastic ingestion by Atlantic chub mackerel (Scomber colias) in the Canary Islands coast. Mar. Pollut. Bull. 139, 127–135. https://doi.org/10.1016/j.marpolbul.2018.12.022.

Herrera, A., Raymond, E., Martínez, I., Álvarez, S., Canning-Clode, J., Gestoso, I., Pham, C.K., Ríos, N., Rodríguez, Y., Gómez, M., 2020. First evaluation of neustonic microplastics in the Macaronesian region, NE Atlantic. Mar. Pollut. Bull. 153 https://doi.org/10.1016/j.marpolbul.2020.110999.

Lavers, J.L., Bond, A.L., 2017. Exceptional and rapid accumulation of anthropogenic debris on one of the world's most remote and pristine islands. Proc. Natl. Acad. Sci. U. S. A. 114, 6052–6055. https://doi.org/10.1073/pnas.1619818114.

Machín, F., Hernández-Guerra, A., Pelegrí, J.L., 2006. Mass fluxes in the Canary Basin. Prog. Oceanogr. 70, 416–447. https://doi.org/10.1016/j.pocean.2006.03.019.

Martín, A., Nogales, M., 1993. Ornithological Importance of the Island of Alegranza (Canary Islands).

Maximenko, N., Hafner, J., Niiler, P., 2012. Pathways of marine debris derived from trajectories of lagrangian drifters. Mar. Pollut. Bull. 65, 51–62. https://doi.org/10.1016/j.marpolbul.2011.04.016.

Morales-Caselles, C., Viejo, J., Martí, E., González-Fernández, D., Pragnell-Raasch, H., González-Gordillo, J.I., Montero, E., Arroyo, G.M., Hanke, G., Salvo, V.S., Basurko, O.C., Mallos, N., Lebreton, L., Echevarría, F., van Emmerik, T., Duarte, C. M., Gálvez, J.A., van Sebille, E., Galgani, F., García, C.M., Ross, P.S., Bartual, A., Ioakeimidis, C., Markalain, G., Isobe, A., Cózar, A., 2021. An inshore–offshore sorting system revealed from global classification of ocean litter. Nat. Sustain. 4, 484–493. https://doi.org/10.1038/s41893-021-00720-8.

MSFD Technical Subgroup on Marine Litter, 2013. Guidance on Monitoring of Marine Litter in European Seas. Publications Office.

OSPAR, 2010. In: Guideline for Monitoring Marine Litter on the Beachs in the OSPAR Maritime Area, 1. OSPAR Commission, p. 84.

Reinold, S., Herrera, A., Hernández-González, C., Gómez, M., 2020. Plastic pollution on eight beaches of Tenerife (Canary Islands, Spain): an annual study. Mar. Pollut. Bull. 151 https://doi.org/10.1016/j.marpolbul.2019.110847.

Rodríguez, B., de León, L., Martín, A., Alonso, J., Nogales, M., 2003. Status and distribution of breeding seabirds in the northern islets of Lanzarote, Canary Islands. In: Atlantic Seabirds, 5, pp. 41–56.

Rodríguez, A., Rodríguez, B., Nazaret Carrasco, M., 2012. High prevalence of parental delivery of plastic debris in Cory's shearwaters (Calonectris diomedea). Mar. Pollut. Bull. 64, 2219–2223. https://doi.org/10.1016/j.marpolbul.2012.06.011.

Sangrà, P., Pelegrí, J.L., Hernández-Guerra, A., Arregui, I., Martín, J.M., Marrero-Díaz, A., Martínez, A., Ratsimandresy, A.W., Rodríguez-Santana, A., 2005. Life history of an anticyclonic eddy. J. Geophys. Res. C Oceans 110, 1–19. https://doi.org/10.1029/2004JC002526.

Sardain, A., Sardain, E., Leung, B., 2019. Global forecasts of shipping traffic and biological invasions to 2050. Nat. Sustain. 2, 274–282.

Savoca, M.S., Wohlfeil, M.E., Ebeler, S.E., Nevitt, G.A., 2016. Marine plastic debris emits a keystone infochemical for olfactory foraging seabirds. Sci. Adv. 2, 1–9. https://doi.org/10.1126/sciadv.1600395.

van Sebille, E., 2014. Adrift.Org.Au - a free, quick and easy tool to quantitatively study planktonic surface drift in the global ocean. J. Exp. Mar. Biol. Ecol. 461, 317–322. https://doi.org/10.1016/j.jembe.2014.09.002.

van Sebille, E., England, M.H., Froyland, G., 2012. Origin, dynamics and evolution of ocean garbage patches from observed surface drifters. Environ. Res. Lett. 7 https://doi.org/10.1088/1748-9326/7/4/044040.

Veiga, J.M., Fleet, D., Kinsey, S., Nilsson, P., Vlachogianni, T., Werner, S., Galgani, F., Thompson, R.C., Dagevos, J., Gago, J., Sobral, P., Cronin, R., 2016. Identifying sources of marine litter. In: MSFD GES TG Marine Litter Thematic Report. JRC Technical Report. https://doi.org/10.2788/018068.