Study of anthropogenic pollution in La Sorpresa, El Saltito, Baja California Sur

Ricard Vergés Tarragona

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May Gómez Cabrera

José Manuel Borges Souza

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Datos personales del estudiante:

Nombre: Ricard Vergés Tarragona

DNI: 48090518W

Fecha de nacimiento: 8 de mayo del 1997

Correo institucional: ricard.verges101@alu.ulpgc.es

Titulación: Grado en Ciencias del Mar

Datos de la tutora académica:

Nombre: May Gómez Cabrera

Departamento: Biología

Institución: Universidad de Las Palmas de Gran Canaria

Correo institucional: may.gomez@ulpgc.es

Datos del cotutor académico:

Nombre: José Manuel Borges Souza

Departamento: Pesquerías y Biología Marina

Institución: Centro Interdisciplinario de Ciencias Marinas (CICIMAR)

Correo institucional: jborges@ipn.mx

FIRMA Y FECHA ESTUDIANTE: **FIRMA Y FECHA TUTORES:**

CONTENTS

1. Abstract

Any dumped artificial object, whether intentionally or not in the marine environment, is considered marine litter. While marine litter consists of all kinds of materials, plastics debris are their major component, negatively affecting aquatic life, leading to socio-economic costs and representing waste of valuable resources (PlasticsEurope, 2017-2018). Plastic debris are amongst the major threats to marine ecosystem, next to industrial fishing and climate change. Many marine species are known to be harmed and/or killed by plastic debris, which could jeopardize their survival, especially since many are already endangered by other forms of anthropogenic activities (Derraik, 2002). The target of this study is to quantify the pollution (mainly anthropogenic and plastic) and its origin on the marine ecosystem of a stretch of La Sorpresa beach, located in El Saltito, Baja California. After sampling an area of approximately 1500 m^2 searching for any object that can easily be seen by the human eye, main sources of pollution, their origin and their effects on the ecosystem were identified. Solid differences were found when comparing marine litter accumulated in the sandy, intertidal, and underwater ecosystems.

Out of 80 sampling spots, only 19 of them there were marine debris free. 5 of them could not be analysed because of their location, and the other 56 of them had at least one object which did not belong there.

Among all the pollutants found (N=401), classified in 25 types and 11 materials, 61% of them were plastics. Regarding what they were specifically, the most common were: 14% fishing lines, 10% plastic bags, 10% aluminium cans, 7% plastic wraps and 7% cigarette butts. Many other types of marine debris were found, but with much less frequency. Surprisingly and against all expectations, only 4 straws were found, representing 1% of all objects.

It was observed that most of the pollution proceeds from tourism, and 50% of it was found in a sandy substrate (both above and below the surface). A solid relationship between the marine debris was observed between the underwater and the intertidal ecosystem, as proved by several Spearman's correlation tests.

Cochran's Q test made according to the presence or absence in the different substrates demonstrates that there is a significant difference between the presence of marine litter existing in each substrate.

2. Introduction

In the oceans, the threat to marine life comes in various forms: overexploitation and harvesting, dumping of waste, pollution, invasive species and global climate change (Beatley, 1991). One particular form of human impact is a major threat to marine life: the pollution by plastic debris (Derraik, 2002). Debris of anthropogenic origin, especially plastics, affect marine biota and ecosystems in many ways. Plastic debris threatens not only the health of our seas and coasts, but also our economy and communities (Barboza et al., 2019).

This is one of the main concerns at the beginning of the 21st century, caused by the industrial production of plastic, especially single-use plastic (SUP). Studies on marine debris have gained worldwide attention since many types of debris have found their way into the food chain of higher organisms. Thus, it is crucial that more focus is given to this area in order to curb contaminations in sea food (Fauziah et al., 2015). It is vital to know in what quantities and by what routes plastics enter the marine ecosystem. It has been estimated that between 4.8 and 12.7 million tonnes of plastic waste end up in the marine environment (Cozar et al., 2014; Jambeck et al., 2015), increasing its prevalence in the marine environment over the years (Camacho et al., 2019).

Plastics are synthetic materials of organic origin, made up of polymers. They are lightweight, inexpensive to manufacture, durable and, to a large extent, non-biodegradable. Characteristics that make them suitable for the manufacture of a wide range of products. These same properties are the reasons why plastics are a serious danger to the environment (Laist, 1987).

Nowadays there are many marine species affected by high levels of plastics (and other pollutants such as heavy metals). A recent study from the Canary Islands proved that from 120 examined fish gastrointestinal tracts, 78.3% contained some type of microplastics, 74.2% contained fibres, 17.5% plastic fragments, and 16.7% paint. More studies are needed on fish, but *S. colias* is a candidate for being a good indicator of microplastic contamination in the region (Herrera et al., 2019).

The ingestion of marine debris by marine wildlife, ranging from zooplankton to marine megafauna (fish, seabirds, sea turtles, and marine mammals) has been widely documented (Di Beneditto and Awabdi, 2014). Plastic can cause direct damage to marine wildlife through entanglement, malnutrition (gut blockage and pseudo-satiation), suffocation and decreased mobility – often resulting in their death (Laist, 1997).

Coastal litter impacts in multiple ways, the most importantly they degrade the quality and health of our oceans, damage coastal and marine habitats and harm marine biota. It is estimated that about 6.4 million tons of marine litter are being disposed in to the seas annually (UNEP, 2009) and that the annual rate of production of plastic has touched 300 million tons in 2010 itself (Thompson et al., 2009). Plastics enter the coastal and marine ecosystem either directly by illegal dumping or accidental loss of debris during fishing / cargo operations and oil rigs or indirectly by way of wind, rivers, streams, and storm drains.

According to the IUCN, plastic pollution has been addressed as a major threat to biodiversity (Salafsky et al., 2018). Plastics and microplastics are found in most of the marine ecosystems of the world, despite the enormous awareness efforts made by many entities to stop the SUP.

2.1 Hypothesis

It is expected that the main source of pollution, even considering the community of resident fishermen, is tourism. It is also expected that the most common type of marine litter is plastic, as stated by Derraik in 2002, and this represents a percentage between 50 to 80%. Difference between marine litter accumulated in each ecosystem and substrate are also envisioned, as well as difference between the amount of marine litter found depending on the season.

2.2 Objectives

The main objective of this study is to quantify all marine debris in the study area and identify and compare the areas in which they are found.

There are three secondary objectives:

- To study the origin of the contamination in order to help developing a possible plan for waste management.
- Compare the presence or absence of marine litter and understand the links between marine litter in each ecosystem and substrate.
- Map the surface current in order to understand if marine debris is accumulating on this beach because of the currents or, on the other hand, once these marine debris enter the sea, they are taken to another place by the currents.

3. Material and methodology

3.1 Study area

After checking different beaches near La Paz, Baja California Sur, La Sorpresa (24º15' N, 110º9' W) beach was chosen. La Sorpresa is located in the northeast of La Paz, in the Sea of Cortez.

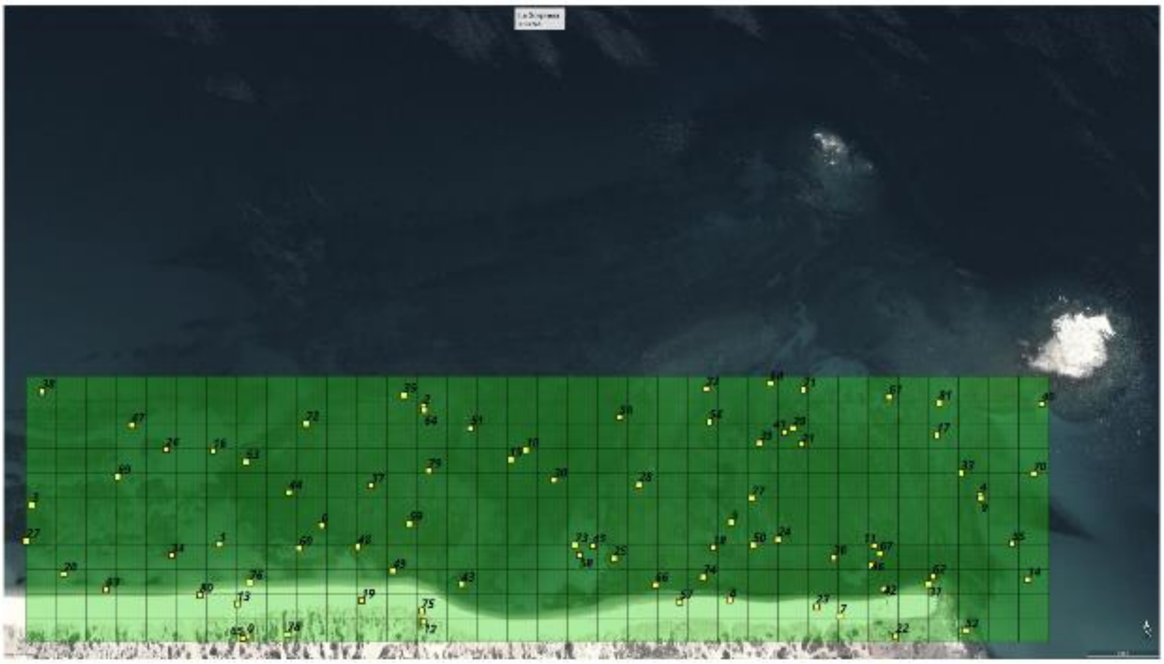

Figure 1. La Sorpresa beach with its sampling spots

The sampling area is a 1500x400m plot, in which 80 points were randomly selected using QGIS, as seen in figure 1. The respective coordinates of the 80 points were installed to a GPS in order to sample accurately each point. First, the 5 terrestrial and 5 intertidal points were sampled, and then, when the weather conditions allowed it, the remaining underwater spots were sampled. Since the main aim of the study is to analyse the consequences in the marine environment, most of the sampling points are underwater.
It should be noted that in the eastern area of the study there is a community formed by approximately 15 resident fishermen.

3.2 Field work

All the data of this study was obtained personally (with the vital help of Dr. José Manuel Borges and Dr. Alejandra Chávez), between November and March of 2019. In November, the first 10 points were sampled, and between February and March, the remaining underwater points were sampled.
All objects were classified in 7 categories into a logbook: material (paper, plastic, metal, glass, carbon, rubber, fiberglass, wood, cloth, organic and nets), type of debris (fishing lines, cigarette butts, plastic wrappers, bags, caps, containers and cutlery, aluminium

cans, glass bottles, unicel dishes glasses, straws, fishing wastes, metals and metal caps, coal, tires, wood, PVC, ghost nets, anchors, clothing, fiberglass, paper), substrate affected (coral, algae, vegetation, invertebrates, vertebrates, sand and rock), ecosystem (sandy, intertidal, underwater), derived activity (tourism and fishing), vehicle (wind, water and humans) and time (recent or less than two weeks and old or greater to two weeks).

3.3 Computer work

Once all the data were collected, they were all classified in a dynamic table in Excel, in order to facilitate the processing of data. Many of the studied parameters were compared: substrate affected, pollution source, type of debris, and others.

With the aim of studying the correlation of marine debris within the substrate or habitat they affect, a Spearman's rank correlation coefficient and matrix was made. Spearman's correlation is used when you want to measure the relationship between two ordinal variables and these variables are related, but not linearly. The value of the coefficient oscillates between -1 and 1. If it is 0, it means that there is no correlation, but no independence. If it is close to 1, it means there is a strong and positive correlation, and if it is close to -1, it means there is a strong and negative correlation. Spearman's correlation coefficient includes both the type and the quantity of marine debris on each area.

With the purpose of understanding the link between presence or absence of marine debris in each substrate and ecosystem without considering the amount nor type of marine debris, a Cochran's Q test was designed. Cochran's Q test requires that the response must be binary (absence / presence) and there are at least 3 groups of the same size, in our case, there were 4 possible substrates and 3 possible ecosystems.

With the goal of finding out if marine litter came from the same population or not, a Kruskal-Wallis test was schemed. Kruskal-Wallis analyses the mean of observations and its amount of marine debris (not the type).

The 3 statistic tests are non-parametric statistical tests, because it can not be assumed that the collected data has any characteristic structure. In non-parametric statistical tests, there is no need of assuming there is a normal distribution nor a linear relation between the predictors and the outcome. Since our data does not fit all the assumptions meant for parametric statistics, an alternative procedure was explored, and non-parametric statistical tests were built.

Finally, with the target of studying the behaviour of marine debris once enters the marine ecosystem, surface current data was downloaded from Copernicus and a surface current map was made with Python. 12 different graphs were made, each one for each month of 2018, in order to understand if there were stationary changes in the currents which could affect in presence or absence of marine debris in the marine ecosystem.

4. Results

4.1 Source of pollution

As mentioned before, all 401 objects (marine debris) found were classified in many different groups. In Figure 2 we can see a pie chart according to their origin.

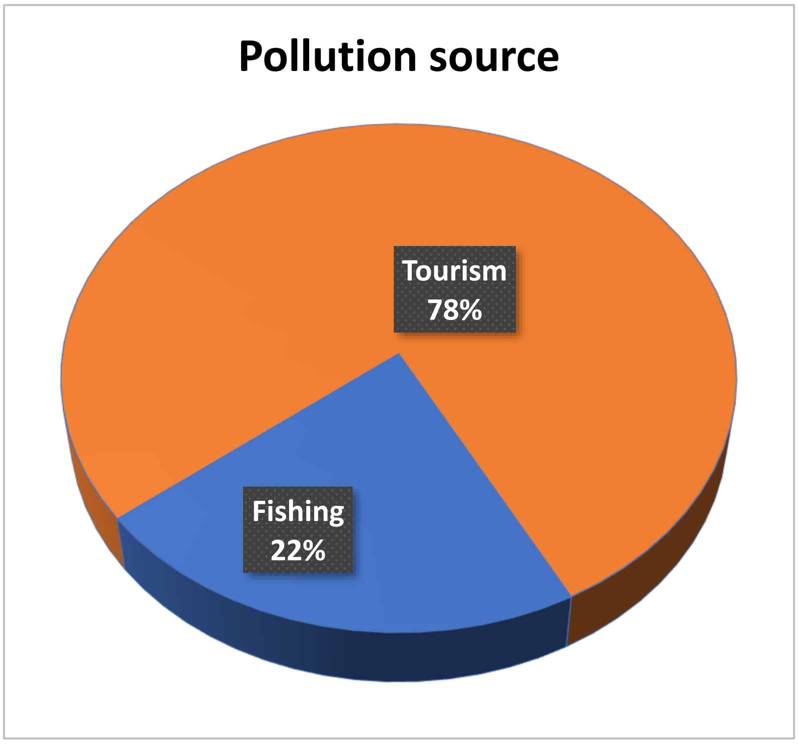

Figure 2. Percentage of the origin of pollution in the study area

In order to know if pollution came from the activity of fishing or tourism, two parameters were considered: the area where the garbage was located and the type of garbage it was. Objects such as anchors, nets, fibreglass (hull of the boat) and fishing waste were considered, wherever they were, to be of fishing origin. As can be seen in the graph, the main source of pollution of La Sorpresa beach is, without any doubt, tourism.

It must be mentioned that what is analysed in Figure 2 are two activities: fishing and tourism. A tourist can modify both sources of pollution: by leaving cans, plastics or other objects (tourism) or leaving fishing lines in the marine ecosystem (fishing).

4.2 Substrate affected

Another important factor is to observe which ecosystem is affected by pollution, regardless of its origin, material, or time. Figure 3 shows the 3 possible substrates where garbage was accumulated. These include coral (often installed on top of a rock), sand (either in the marine or terrestrial ecosystem) and vegetation (in the terrestrial ecosystem).

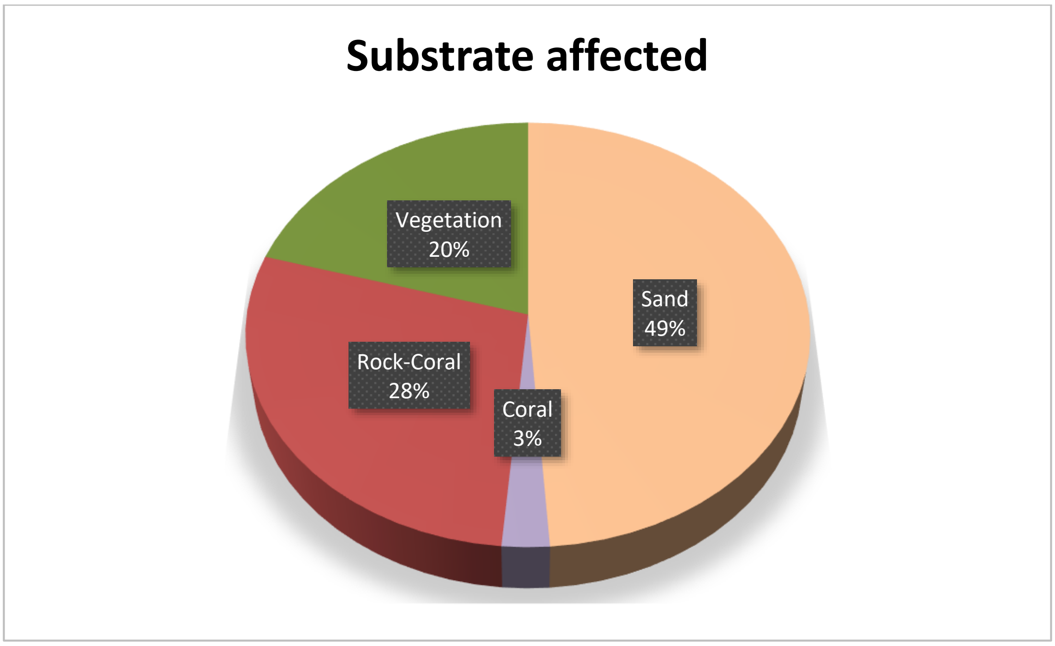

Figure 3. Percentage of garbage found in each substrate.

As we see in Figure 3, almost half of the trash was found in the sand, either on the seabed or on the beach. 15% (30 out of 195) of the objects found in the sand were cigarette butts. Cigarette butts are the most common form of garbage, with an estimated $4.5x10^9$ cigarette butts thrown out worldwide each year (Slaughter et al., 2011). The rest were mainly fishing lines (dragged by the tide or left by fishermen), bottle caps, aluminium cans, plastic containers, plastic bags and unicel cups. Also found, to a lesser extent, were ghost nets, plastic cutlery, glass bottles, tires, unicel plates, clothing and metal lids (from glass containers).

The second substrate with more marine debris found was the coral reef, either together with rocks or being only coral. 123 items found on only 44 sample points were the substrate was coral reef (unfortunately, only 7 of them were marine debris free). 40 fishing lines or ghost nets were found in 26 sampling points out of 44. This means that in 60% of the sampling points there a chance of, at least, finding one entangled fishing line or net in a coral. And, since there were 123 marine debris found on the 44 stations, fishing lines and ghost nets represent the 32,5% of all that garbage.

Despite being there only 3 sampling points where the substrate was vegetation, there were 82 marine debris in these points. Mostly, they were plastic bags (16%), unicel glasses (16%) and aluminium cans (12%). Among others, there were remains of bonfire, straws, plastic cutlery, and other single use plastic. All these items proceed from camping activities, or, as mentioned before, tourism.

4.3 Type of marine debris

With the aim of proposing a solution to the huge pollution problem we are facing, it is of vital importance to know what kind of marine debris is found in the study area. Figure 4 shows, from higher to lower frequency, the different types of garbage encountered.

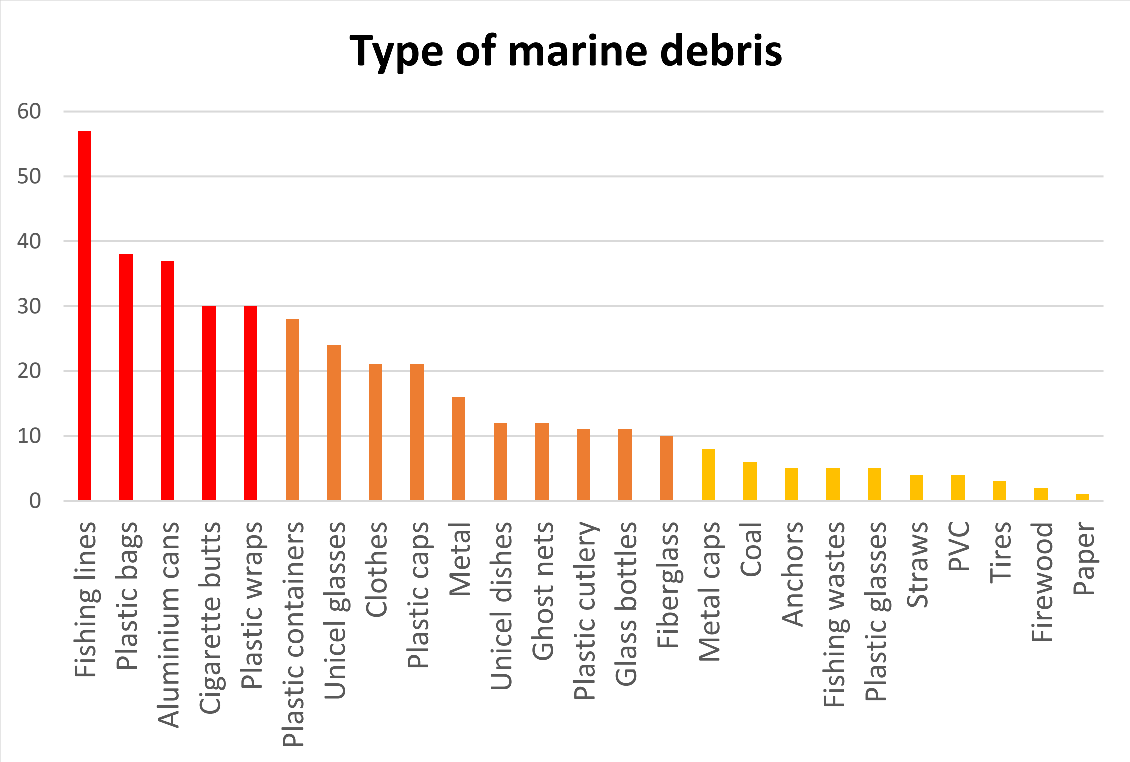

Figure 4. Marine debris found classified within their type.

Among the many possible classifications, figure 4 shows in red the high concern garbage, in orange the medium concern and, in yellow, the lowest concern (referring to the amount of times every marine debris was found). This doesn't mean that the yellow is not to be worried, but that first we should worry about garbage in red, since they appear up to 50 times more.

As seen in figure 4, the most common marine debris detected was fishing lines, followed by plastic bags and aluminium cans. These 3, together with cigarette butts and plastic wraps, represent the high concern marine debris in our study area, since they are encountered 30 or more times in only 75 sampling points. Medium concern marine debris are those encountered between 10 and 29 times, which are, in a decreasing order: plastic containers, unicel glasses, clothes, plastic caps, metal, unicel dishes, ghost nets, plastic cutlery, glass bottles and fiberglass. As previously mentioned, this classification only refers to the frequency in which different types of garbage is found, not to the possible damage it creates to the environment. Classified as least concern, surprisingly, there are the straws. Only 4 straws in 75 sampling spots. This does not mean the battle against straws has ended, but it means that other battles against other marine debris must start, such as fishing lines, ghost nets, plastic bags and cigarette butts.

4.4 Spearman's correlation

Figure 5 shows Spearman's correlation coefficient between the 3 ecosystems were marine debris were found, in order to understand the relationship among the ecosystems.

As mentioned before, when the coefficient is 1 it indicates a strong and positive relationship. Obviously, when comparing marine debris found in the sandy area with marine debris found in the same ecosystem, the coefficient is 1. When marine debris found in the underwater ecosystem are compared with the intertidal one, the coefficient is 0,51. This indicates a positive and moderate / strong relationship. 0,39, the coefficient between the intertidal and the sandy ecosystem, indicates there is a positive relation among the marine debris found on each site, yet it is a weak relationship.

By last, there is a negative and very weak relationship between the sandy and the underwater ecosystem.

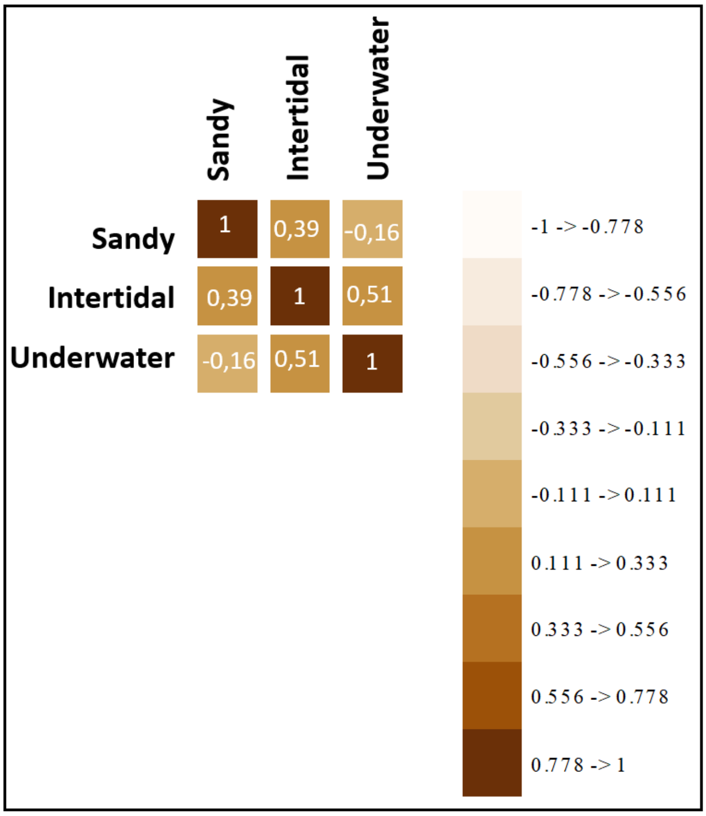

Figure 5.Spearman's coefficient matrix image.

Figure 6 displays the correlation of the marine debris found on each substrate. As we can see, vegetation presents no correlation with the sandy ecosystem. The same happened with coral and rock-coral substrate, the relationship is null or scarce. The strongest correlation is found between the rock-coral and sandy ecosystem, but it is not a very strong one, since the coefficient is 0,43. Relations between the coral and the sandy ecosystem is positive but weak.

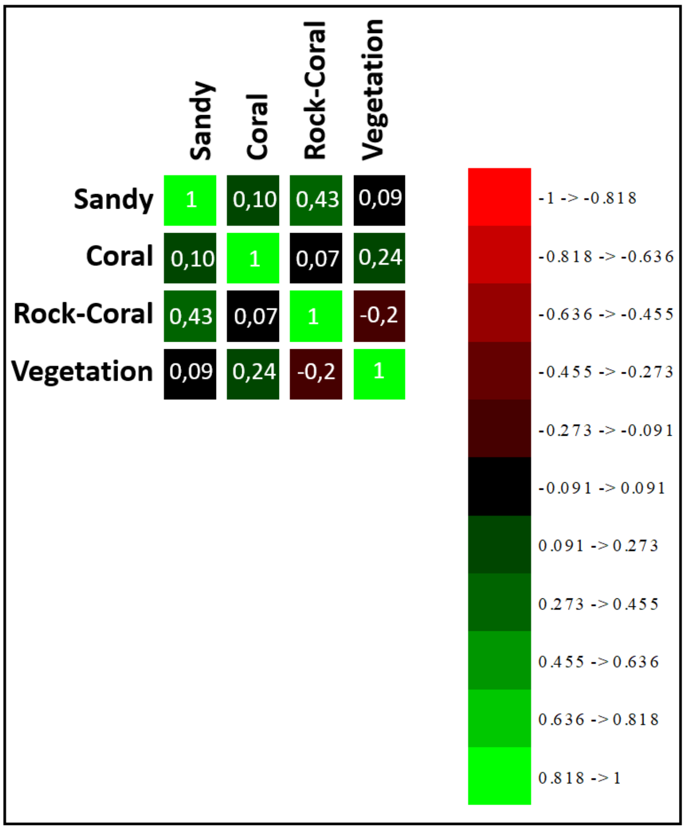

Figure 6. Spearman's coefficient matrix image

4.5 Cochran's Q test

As mentioned before, Cochran's test goal is to recognize if there's a significant difference between presence of marine litter in each substrate / ecosystem, without considering the amount nor the type of marine litter.
H_0 means that there is no difference when it comes to presence of marine letter, and H_a means that there is significant difference between the presence of marine litter.
Using an α of 0,05, when the p-value is less than α, the null hypothesis, H_0, must be rejected and the alternative hypothesis, H_a, must be accepted. In the other hand, if p-value is greater than α, H_0 can not be rejected.

Table 1. Descriptive statistics used on Cochran's Q test for substrate.

	Category	**Frequency**	**%**
Sandy	0	5	20
	1	20	80
Coral	0	22	88
	1	3	12
Rock-Coral	0	12	48
	1	13	52
Vegetation	0	12	48
	1	13	52

Table 2. Descriptive statistics used on Cochran's Q test for ecosystems

	Category	**Frequency**	**%**
Sandy	0	10	40
	1	15	60
Intertidal	0	8	32
	1	17	68
Underwater	0	7	28
	1	18	72

In table 1, p-value (as shown on table 8 on the Annex) is less than 0,00001, so the null hypothesis must be rejected, and the alternative must be accepted. This means that there is a significant difference between the presence of marine litter in each substrate.
In table 2, p-value (as shown on table 9 on the Annex) higher than α, so the null hypothesis can not be rejected. This means that there is no significant difference when it comes to presence / absence of marine litter on each ecosystem. Marine litter is present in the same proportions on each ecosystem, but this does not contemplate the quantity or the type of marine debris on each zone.

4.6 Kruskal-Wallis test

In this study, Kruskal-Wallis is analysing the mean of the amount of marine litter of the observations, not the median.
H_0 means that the marine litter comes from the same population and H_a means the exact opposite.

Table 3. Kruskal-Wallis test with p-values for ecosystems

	Sandy	Intertidal	Underwater
Sandy	**1**	0,992	0,141
Intertidal	0,992	**1**	0,239
Underwater	0,141	0,239	**1**

Table 4. Kruskal-Wallis with significant difference for ecosystems

	Sandy	Intertidal	Underwater
Sandy		No	No
Intertidal	No		No
Underwater	No	No	

As seen on table 3, all p-values happen to be higher than α, so there is no significant difference between the marine litter found on each ecosystem, thus the marine litter comes from the same population.

Table 5. Kruskal-Wallis with p-values for substrates

	Sandy	Coral	Rock-Coral	Vegetation
Sandy	**1**	**< 0.0001**	0,163	0,092
Coral	**< 0.0001**	**1**	**0,009**	**0,010**
Rock-Coral	0,163	**0,009**	**1**	1,000
Vegetation	0,092	**0,010**	1,000	1

Table 6. Kruskal-Wallis with significant differences for substrates

	Sandy	Coral	Rock-Coral	Vegetation
Sandy		**Yes**	No	No
Coral	**Yes**		**Yes**	**Yes**
Rock-Coral	No	**Yes**		No
Vegetation	No	**Yes**	No	

As seen on table 5, p-value is less than α when comparing coral with any other substrate. This means that marine litter found exclusively on coral is from a different population than marine litter found on other substrates. There are no significant differences between any other substrate.

5. Discussion

There is clear evidence that plastic pollution is a huge threat to the marine ecosystem, which is already in danger due to other factors such as industrial fishing and climate change. The only positive aspect there could be when it comes to marine debris is that, to certain populations, they can be used as shelter. The presence of litter on deep water sedimentary bottoms increases the overall biodiversity of particular areas. (Pace et al., 2017).

Over 60% of all the pollutants are represented by plastics, being mainly fishing lines entangled to coral reef, bags and wrappers, most of them introduced to the marine ecosystem by the activity of tourism. Unfortunately, the dumping of plastic debris into the ocean is an increasing problem (Derraik, 2002). Plastics have been found in the air, soil, fresh water, seawater, deep-sea sediments, and sea ice. They are recognized as new habitat for organisms (Baztan et al., 2017). Fishing gear used in coral reef areas is known to cause direct physical damage to the reef substratum (Jennings and Kaiser, 1998). There is (1) a positive correlation between percentage of dead colonies and percentage of colonies with fishing lines; (2) a higher percent dead area in colonies with fishing lines than colonies without fishing lines; (3) a positive correlation between percent area with fishing lines and percent dead area in colonies with fishing lines. Moreover, the scarcity of large colonies without fishing lines suggested that any colony would eventually become inflicted by fishing lines as they grew older and larger (Yoshikawa and Asoh, 2004). Plastic debris accounts for 92% of entanglement and ingestion cases (Schepis, 2016) and around 17% of all species involved are on the IUCN Red List of Threatened Species, listed as near threatened, vulnerable, endangered or critically endangered (Gall and Thompson, 2015). Entanglement happens when the loops and openings of any type of debris entangle animal appendages or entrap it, often resulting in death by drowning, suffocation, or strangulation (Laist, 1997; Moore, 2008).

The coastal landscape is frequently impacted by marine litter that impairs recreational uses and causes a loss of touristic value. Beyond the aesthetic impact, marine litter also bears potential economic implications to maritime activities, such as fisheries and the aquaculture sectors (UNEP, 2014). It may also affect the marine environment and the different ecosystem components.

After analysing all the data collected in the study area, it seems that the famous fight against straws has been more than effective, but further studies in other beaches are recommended. Yet the battle against marine pollution, specifically against single use plastic, has not done anything yet but started.

After Easter, a quick check in La Sorpresa was made. Non surprisingly, the beach was at a lot dirtier. Many remains of campers were found: coal, firewood and much more plastic. This supports figure 2, which states that almost all the pollution comes from the activity of tourism and not from fishing, since fishing did not stop during Easter, and tourism skyrocketed in the study area. A management plan, including the installation of more trash cans and awareness campaigns is highly recommended, since in only one week the amount of marine litter tripled, all dumped in the floor or next to trash cans (they were full), and all that marine litter will only disappear by entering the marine ecosystem.

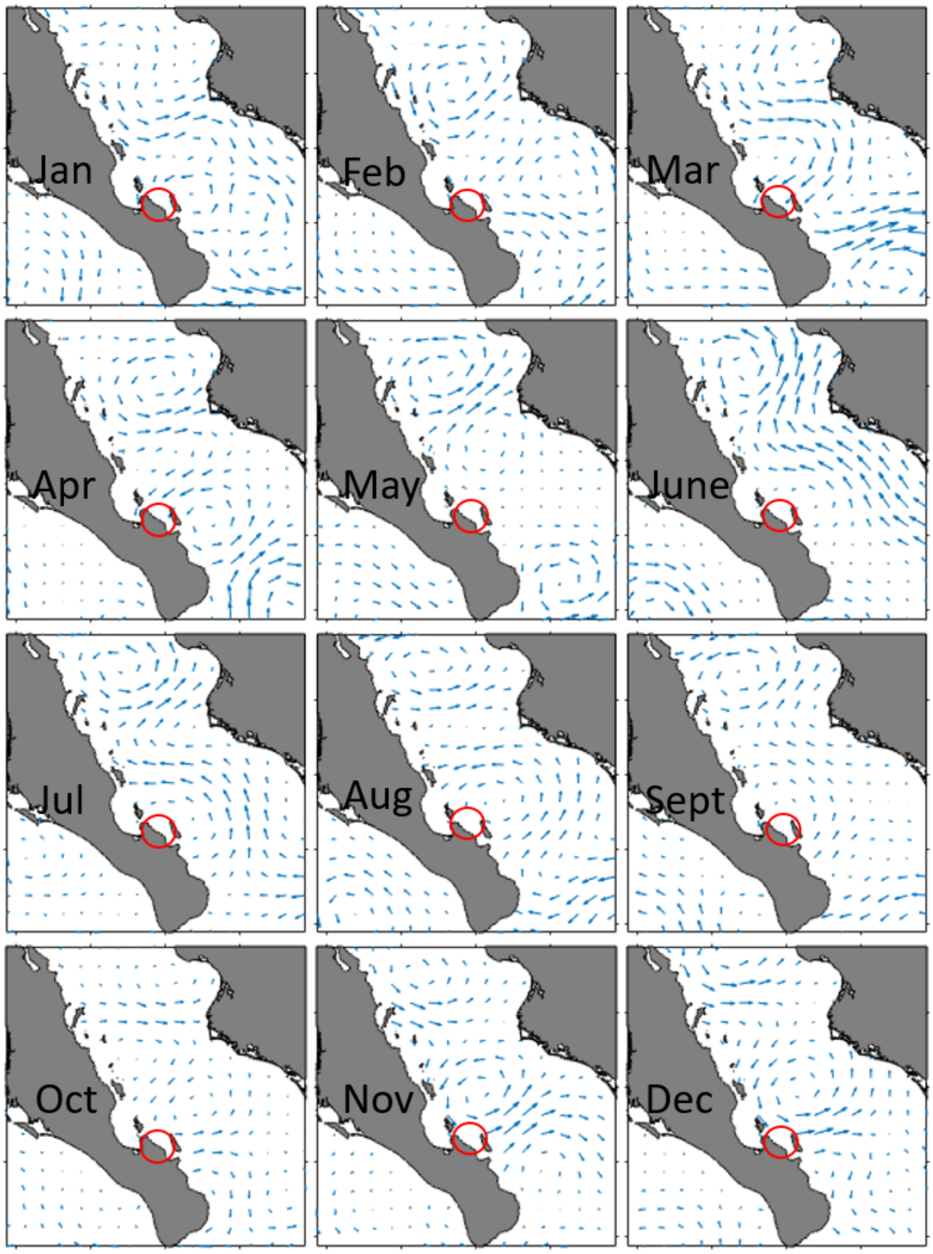

Figure 7. Surface current map of Southern Californian Gulf

This map was made in order to understand if marine debris were exported from the shoreline to the open seas or, to the contrary, marine debris came from open seas right into the study area.

As we can see in figure 7, the first 4 months it appears that current goes right into El Saltito Beach, but with a low intensity. The 8 remaining months, current does not really hit El Saltito Beach, since it is protected by Cerralvo.

6. Conclusions

1. It is confirmed that the main source of pollution comes from the activity of tourism and not fishing, with an approximately 78% of pollutants coming from the first activity against 22% with an origin of fishing activity.
2. Almost 50% of the overall marine litter was found in the sand, above and below the surface. It must be said that a high percentage of such marine debris was constantly moving until it hit a rougher substrate, being this rock, coral, or vegetation.
3. There happens to be a strong relationship between marine litter found in the underwater ecosystem and in the intertidal ecosystem, as proved by Spearman's correlation coefficient. There is no correlation between the other ecosystems (sandy vs underwater and sandy vs intertidal). No conclusions can be made when comparing the substrate were marine litter is accumulated, since the correlation coefficients are too close to 0.
4. As shown in table 1 and 8, according to the different existing substrates (sandy, coral, rock-coral and vegetation), through a Cochran's Q test it was determined that there is a significant difference regarding the presence or absence of marine litter. On the other hand, in terms of ecosystems (sandy, intertidal and underwater) there is no significant difference in terms of presence of marine litter. Cochran's Q test only applies to the presence or absence of marine litter, it is not examining the amount of marine debris nor the type.
5. From Kruskal-Wallis test it can be affirmed that there is no significant difference when studying the origin of marine litter found on each specific ecosystem, so it can be concluded that, in this case, marine litter comes from the same population. In addition to studying the origin on each ecosystem, the same study but for each substrate was made. In this case, there are significant differences only with one substrate: coral. Marine litter found exclusively on the coral substrate happens to come from a different population.
6. Ocean currents do not increase nor decrease the amount of marine debris found in our study area.

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9. Annex

- **Logbook**

Table 7. Logbook taken to the field

Station
Material
Type of marine debris
Substrate affected
Ecosystem affected
Pollution source
Degradation time
Vehicle

As we can see in Table 7, once in the field, this was the methodology followed. First, with the GPS, we went to the desired station, and then, everything we found was written in the logbook. Degradation time was not considered since it could not be determined in many marine debris.

- **Cochran's Q test**

Table 8. Cochran's Q test, p-value for substrate.

C (Observed value)	21,741
C (Critical value)	7,815
GL	3
p-value	< 0.0001
alpha	0,05

Table 9. Cochran's Q test, p-value for ecosystem.

C (Observed value)	0,824
C (Critical value)	5,991
GL	2
p-value	0,662
alpha	0,05

Memoria del final de Trabajo de Final de Título

Actividades desarrolladas durante la realización del TFT:

- Búsqueda bibliográfica a través de, principalmente, Scopus, Faro, Research gate, Google Scholar y Sci-Hub.
- Metodologías para muestreos en campo: uso de QGIS y Google Earth.
- Procesamiento de datos a través de Excel y Excel Xlsx. Análisis de datos: elaboración de tablas dinámicas, análisis estadísticos (Spearman, Cochran y Kruskal-Wallis) e interpretación de resultados.
- Escritura de una memoria y presentación en inglés.

Formación recibida

- Diseño de bitácora y procedimiento a seguir para muestrear el nivel de contaminación de la zona de estudio.
- Uso de Google Earth, QGIS, Excel y Excel Xlsx para el análisis de datos.
- Escritura de una memoria y presentación en inglés.

Nivel de integración e implicación dentro del departamento y relaciones con el personal

La relación con el Dr. José Manuel Borges Souza y con la Dra. Alejandra Chávez ha sido de lo más positiva posible. Llegué al doctor gracias a que me habían recomendado que si quería trabajar con plásticos o conservación marina tenía que acudir a él, y así hice. No solo me ayudaron a desarrollar toda la tesis (des de cómo hacer los nuestros, herramientas para tratar los datos, escribir la memoria,…), sino que también me han recomendado posibles maestrías y otras vías para seguir formándome en el campo de la conservación marina, por lo que les estoy muy agradecido.

Aspectos positivos y negativos más significativos relacionados con el desarrollo del TFT

La parte más positiva del TFT ha sido que por primera vez en mi vida me he visto centrado en un proyecto que yo mismo desarrollé, y a pesar de los múltiples contratiempos, al ser un trabajo que me interesa y me agrada, no se me ha hecho muy pesado dedicarle su tiempo cada día. Después de haber leído tantos artículos relacionados con la contaminación marina, me he dado cuenta de que el problema al que nos enfrentamos es muchísimo mayor de lo que pensaba, y esto es algo positivo, ya que quiero hacer algo al respecto. Hay que añadir también que mi inglés, sobre todo en el campo que he estudiado, ha mejorado mucho.

Como aspectos negativos del TFT, tengo que confesar que el estar cada día trabajando sobre lo mismo no ha sido fácil. Sí, me gustaba lo que estaba haciendo, pero también me he encontrado con una serie de obstáculos que me frenaban, y me estancaba 3 o 4 días con lo mismo. Por suerte, siempre podía recurrir a mis tutores, de los cuales nunca me faltó nada.

Valoración personal del aprendizaje conseguido a lo largo del TFT

Creo que la realización del TFT es vital para conocer cuál es el trabajo de un científico, o, al menos, parte de él. Todo el trabajo hecho en B.C.S. relacionado con el TFT me ha consolidado como científico, y me ha enseñado la metodología a seguir para escribir un artículo científico. Mi conocimiento sobre el tema de mi TFT ha aumentado con creces, y eso me ha hecho crecer como persona. El desarrollar el TFT me ha abierto la mente en muchos aspectos, y creo que me ha ayudado a saber que camino profesional tomar.