A Plastic Survey of Blue Bay and Pointe D'Esny, Mauritius

Graham Shelbourne & Nicholas Ray
Nottingham Trent University,
School of Animal, Rural & Environmental Sciences,
Burton Street, Nottingham, NG1 4BU, U.K.
[*graham.shelbourne@ntu.ac.uk*]

Abstract: Plastic waste, in particular neustonic waste poses a threat to wildlife. Blue Bay is situated on the south east coast of Mauritius and is a 20km^2 shallow lagoon with a fringing reef and a number of islets. It includes an area designated a marine park in 2000. The lagoon contains 38 species of coral and 125 species of fish. The outer reef protects the island from incoming neustonic plastic fragments creating an opportunity to identify anthropogenic debris from the mainland. Beach surveys and tropical forest surveys used finger-tip searches to a depth of 2cm whereas as underwater surveys used quadrats and the roving diver technique. 28 transects and quadrats were surveyed in total over a 2 week period (March/April 2012). The fragments were analysed using the Resin Identification Code. The results indicate 1 beach location with higher levels of plastic fragments. These represent a threat to the local wildlife primarily through ingestion. Protected areas including the marine park and Ille Aux Aigrette show low levels of plastic debris.

Introduction

Plastic (synthetic polymer) debris is known to be a global threat to our oceans (Derraik 2002, Moore, 2008 & Cole *et al* 2011). Its qualities of lightness and durability are both a benefit and a cost (Ryan *et al* 2009). Neustonic waste has been extensively demonstrated to be a serious threat to marine life (Fowler 1987; Ryan 1987; Bjorndal *et al* 1994; Moore *et al* 2001). Further evidence was obtained from the North Western Mediterranean Sea by Collignon *etal* (2012) and together with numerous other studies (Shiber 1979, Cadee 2002 & Otley & Ingham 2003) confirmed it as a global issue. Human discards have resulted in a serious threat to marine life. Bugoni *et al* 2001 reported that 13.2% of dead green turtles (C*helonia midas*) examined in Rio Grande de Sul in Brazil died as a result of plastic debris ingestion and a further 13.6% died as a result of fishing activities. Neustonic waste has further been shown to act as a breeding ground for some species which seek refuge on this material and travel on currents around the oceans (Gutow & Frank 2003) ultimately providing a vehicle for invasive species. According to Barnes (2002) human litter doubles the opportunities for rafting biota. Neustonic waste was predicted by Day *et al* (1988) to become a threat to human health where they entered the food chain. Swan (2008) showed that phthalates have an anti-androgenic effect on human reproduction. Furthermore exposure to phthalate esters have been shown to produce abnormal reproductive development in male rats (Howdeshell *et al* 2008) and bio-persistent organic pollutants (POPs,) shown by Mato *et al* 2001 and Rios *et al* (2007) to adhere to plastic debris, have been shown to reduce sperm chromatin integrity in Intuits (Bonde *et al* 2008). These POPs include polychlorinated biphenyl (PCBs) known to cause cancer in animals and may do so in humans (Endo 2005). It is with these issues in mind that this study was undertaken.

Pointe D'Esny, Mauritius has a fringing reef system encompassing an area of approximately 20km^2. This includes a MPA of 353ha managed by the Albion Ministry of Fisheries Research Centre. The bay is therefore protected from the immigration of neustonic plastic by the reef structures and the turbidity of the pelagic ocean. With a human population in 2005 of 1.2 million this is expected to increase to 1.41 million by 2020 (Richmond 2011) increasing the pressure on marine resources. Potential sources of plastic debris are the mainland of Mauritius or enclosed islands or the Indian Ocean Gyres. The area was subjected to a range of destructive processes in the 20th century including overfishing, mechanical or chemical destruction of the reef and non-recycled discharge (Lagon Bleu 2012). Mahebourg is the local fishing centre (Expedition Tour 2012) with a strong tradition of artisanal fishing and an active fish market where tangs, parrot fish and wrasse caught in the lagoon have been photographed for sale.

Ile aux Aigrette is located in the lagoon approximately 800 metres from the mainland (Lat 20°25'13.45"S Long 57°43'58.88"E) and is a coralline island subject to restoration by Mauritian Wildlife Foundation. The island is divided in to 1624 permanent quadrats (12.5 x 12.5 metres) identified by posts in the ground. A parallel project facilitated the acquisition of plastics data.

This study aimed to ascertain the levels and nature of plastic debris in the lagoon of Pointe D'Esny (from Latitude 20°27'17.82"S/Longitude 57°41'58.87"E to Latitude 20°23'39.84"S/Longitude 57°45'14.98"E). Objectives were identified as clarifying the quantity of plastic debris, the nature of that debris and to locate specific areas subject to the highest density. Additionally analysis of the debris was intended to ascertain if particular types of plastic could have a common source.

The Republic of Mauritius web-site (2012) lists five companies registered for recycling plastic which are Polypet Recyclers Ltd, DKD Co Ltd, Philip Polybag Manufacturer Co. Ltd, Plaspak Group and Viper Transport & Co Ltd.

Methodology

A review of methods by Rees & Pond (1995) and a further study by Velander & Mocogni (1999) proved valuable in choosing effective methods appropriate to a range of environments from public beaches, tropical coastal forest and 20 metre deep dive sites. Most of the reviewed methods were constrained by solo investigation. This study had 14 Nottingham Trent University undergraduates completing data collection. Beach surveys and tropical forest surveys used finger-tip searches to a depth of 2cm whereas as underwater surveys used line transects and the roving diver technique (Schmitt *et. al*. 2002). In order to obtain useful data measurements were equated to fragments per m^2. Araujo *etal* (2006) demonstrated that the most effective areas to be targeted for sample collection covered a 15 metre width of the littoral zone above the high tide mark and this was the approach selected. Ryan *et al* (2009), following a review of methods, recommended to The United Nations Environment Programme (UNEP) suggests that standing stock surveys should cover 50m distances although they subsequently suggested 100m. Due to local anthropogenic topography these surveys were conducted over 30m transects. Where variations occurred as a result of vegetation these areas were also searched. Where man-made structures were present the loss of search area

was compensated for in the estimation of fragments per m^2. 27 transects and quadrats were surveyed in total over a 2 week period (March/April 2012). The fragments themselves were identified using the Resin Identification Code (American Chemistry Council 2011) and results recorded in the field using Microsoft Excel. This method was selected in order to ascertain where plastic types were appropriate for recycling and is globally the industry standard. This was possible with land based collection but where roving diver techniques were employed underwater this was not possible. Results for these are therefore dealt with separately. The range sites are identified as follows: 14 quadrats on IAA, 5 dive sites, 4 beach quadrats, 3 Snorkelling quadrats and 1 quadrat on outlying island (Ile de Fouquet, Lat 20°23'44.33"S – Long 57°46'36.37"E). One site was repeated to check the validity of the method and results were congruent.

Underwater areas searched by scuba diving concentrated on 2 dive sites, each repeated in order to provide an estimate of the accuracy by comparing data. Recovery was also restricted in line with standard safety protocols.

Results

The results show that all mainland sites tested (4) were found to contain varying amounts of debris and this was heaviest in the areas of the public beaches. Deeper areas of the lagoon lower levels of debris and a national reserve established on Ile aux Aigrette had even less (courtesy of the Mauritian Wildlife Foundation). In total 27 sites were sampled (one repeated) over a two week period. Fig.1 shows the quantities of plastic collected from each area.

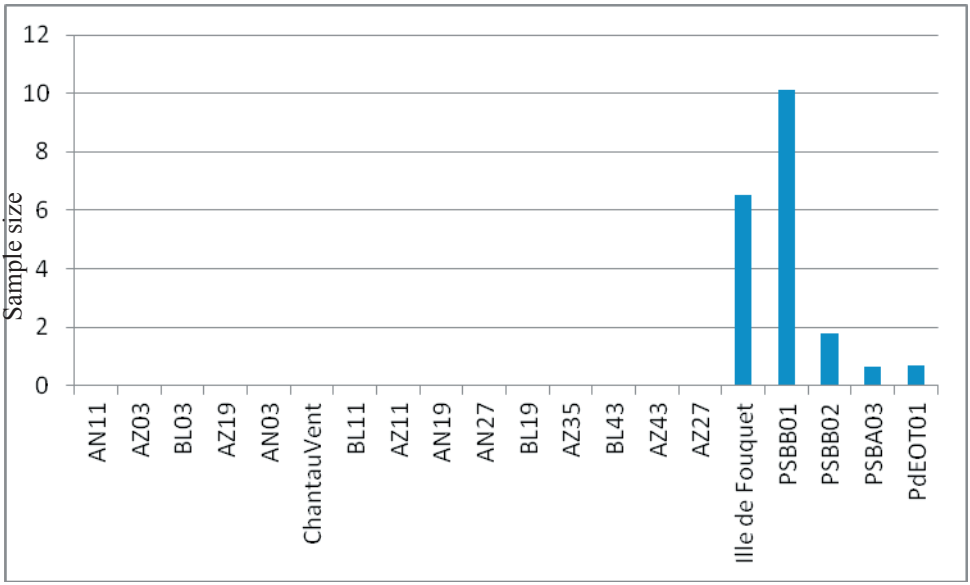

Fig.1 Plastic debris quantities over survey areas.

These results identified very specific areas where deposition was high and these finding will be discussed later in this paper. Fig.2 shows the results from the underwater surveys using the roving diver technique, demonstrating considerable differences on repeated dives although this may be disproportionate as a result of the relatively low quantities found.

As well as the quantity of fragments collected the types were also identified and can be seen in Fig.3. These data may identify where recycling potential exists for comparison with available resources on the island.

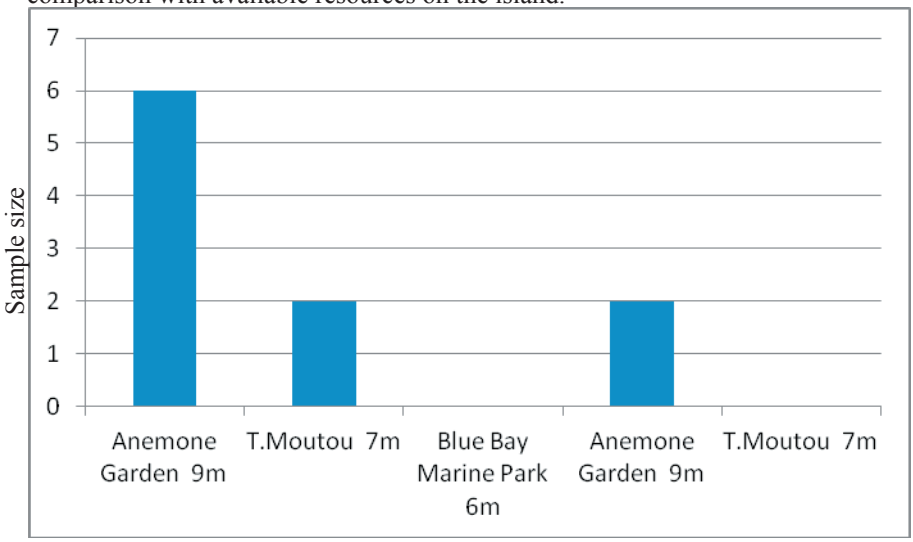

Fig. 2 Data collected by scuba diving using the roving diver technique.

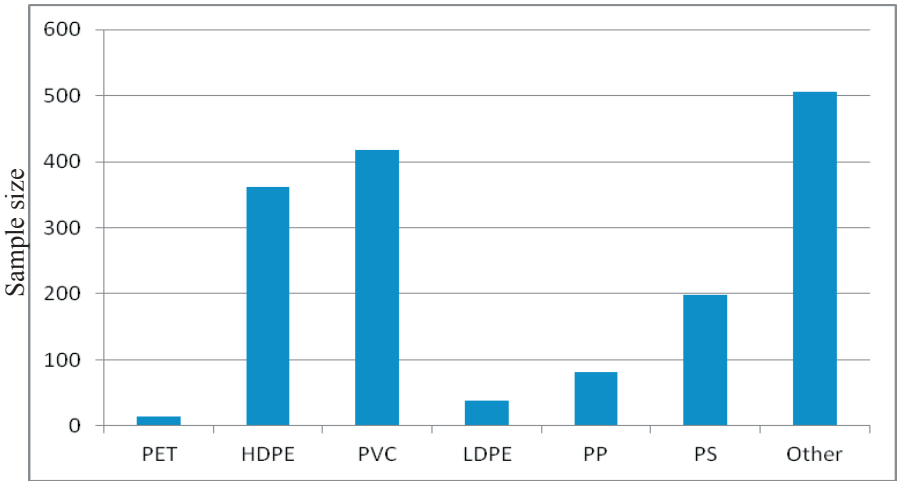

Fig.3 Analysis of data collected by plastic type across all sites.

Discussion

The levels of plastic debris appear to be relatively low around the lagoon with two specific exceptions. Ile de Fouquet is an outlying island located within the lagoon and despite an absence of facilities, jetty or toilets. It is very popular with locals for picnics and family celebrations. As a result large amounts of detritus can be found on the island with a limited waste collection service. The location is susceptible to strong winds and there is therefore a high potential for debris to be deposited in the surrounding marine environment. Ad-lib observations at the time recorded high numbers of visitors and overflowing rubbish bins with material piled up next to the bins. This indicates that many visitors seek to place their waste in an appropriate area assuming it will be collected. *Ergo* either visitors need to remove their own waste or provision needs to be made for its collection. Of particular concern is the presence of nesting areas for *Phaethon lepturus*. It is a surface plunging bird taking fish and squid but may be vulnerable to ingestion of neustonic waste. The island is home to a number of reptile species, some of which are endangered or vulnerable.

The most substantial amount of debris was found at PSBB01 (Lat 20°26'33.71"S – Long 57°42'46.59"E) which was a transect on the public beach. This location was randomly selected and from a length of public beach popular with the locals, particularly on Sundays. This survey was completed on a Monday and indicative of debris left overnight. It would have been useful to categorise the types of items to identify if there were opportunities to target future items for recycling. This should be considered with future studies. Items that were specifically identified included baler twine, glow sticks (used by locals at night) and flip-flop shoes. It was noticeable that there was a virtual complete absence of drink bottles. This may be as a result of a recycling scheme which, on this evidence would seem to be very effective.

A second section of the public beach surveyed was adjacent to a jetty (Lat 20°26'39.16"S- Long 57°42'59.82"E) where tourists boats moored and hence attracted a lot of visitors. It may therefore be considered surprising, not that levels were high, but in fact they were lower than anticipated. Local skippers reported that one reason for this was that their crews did a certain amount of cleaning of the area themselves.

The results for the roving diver collections were more complex. It is worth stating that the quantity of plastic collected was low in comparison to land transects, however these results are constrained considerably by the environment. Undoubtedly the data would have been more reliable had underwater transects been laid in a more traditional manner. This method was used with some snorkelling surveys in shallow water where surface GPS could accurately confirm the location. The roving diver technique does allow for the gathering of evidence but is unlikely to be consistent on repeat dives and would make year on year comparisons difficult. The location is difficult to accurately identify and may require the use of permanent markers of some kind. This practice is prohibited by the Albion Research Centre in order to protect the lagoon. Representation will need to be made in the light of this study to see if this can be agreed. These would also facilitate parallel studies on biodiversity and abundance. Alternatively more repeated dives would provide better data. This review needs to be completed prior to further surveys being undertaken.

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