

COMBATING PLASTIC POLLUTION AND RAISING PUBLIC AWARENESS IN NORTHERN CYPRUS

Final Technical Report

Abstract

Northern Cyprus boarders a Mediterranean marine plastic hotspot and may also contribute significantly to plastic leakage in the region. In addition to a series of awareness raising activities and investigations toward improved waste management, this report outlines the findings of investigations by University of Exeter PhD student Ceren Barlas, into the impact of marine plastics on sea turtle nesting habitats.

Ceren Barlas
c.barlas@exeter.ac.uk

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I. Microplastic pollution survey of marine turtle nesting site sediments

The beaches of Northern Cyprus are nesting grounds for an estimated 30% of green (*Chelonia mydas*) and 10% of loggerhead turtles (*Caretta caretta*) found in the Mediterranean (Broderick and Godley, 1996). Due to temperature dependent sex determination of sea turtles, any change in the physical environment of nests that can affect the incubation temperature, is likely to have subsequent impacts on nest hatching success and sex ratio of hatchlings. Such changes could have important long term effects on these threatened species. A potential disturbance to the life cycle of Mediterranean marine turtles is from the plastic pollution on Northern Cyprus nesting beaches, where Duncan et al. (2018) have found an alarming level of microplastic pollution.

Through the BeMed Micro Initiative, sixteen nesting beaches in Northern Cyprus were sampled between July and September 2020 (Figure 1).

Figure 1. Locations of the 16 beaches sampled. Beach number 9 could not be sampled due to restricted access.

Out of the 680 samples aimed for according to the protocol (40 per beach), a total of 599 sediment samples were collected from a total length of 14 km (Table 1). The 81 samples not collected were due to hitting rock at a certain depth, coming to a rocky portion of the beach, or having no access to the beach (Table 2).

Table 1. Number, name, length, coordinates of beaches sampled, and the number of samples collected from each beach, July-September 2020.

Beach number	Beach name	Beach length (m)	Number of samples collected	Beach Coordinates
1	Monster	2,200	22	35.29311, 32.93944
2	West 2	765	40	35.32631, 32.93527
3	Message	243	39	35.36705, 32.92333
4	Alagadi 1	1,100	40	35.33255, 33.48277
5	Alagadi 2	650	39	35.33463, 33.49305
6	Esentepe 2	120	39	35.35416, 33.59750
7	Mersinlik	250	37	35.41191, 33.83416
8	Kantara	90	38	35.41592, 33.86361
10	Ronnas Bay 1	330	40	35.60072, 34.33388
11	Ayphilon	600	40	35.62633, 34.36972
12	Sea Bird	145	39	35.66666, 34.57222
13	Golden	2,700	40	35.64116, 34.54694
14	Greenfields 2	750	35	35.52297, 34.33972
15	Bafra	1,260	40	35.36511, 34.07944
16	Bahceler	441	39	35.27869, 33.92500
17	Glapsides	2,313	32	35.16805, 33.90944
	Total	13,957	599	

Table 2. Example of sediment data collected during the microplastics survey, July-September 2020.

Sample number	Unique Sample Code	Sampling Date	Beach Name	Beach Number	Sample location	Sample depth*	250cm³ sample weight (g)
1	1_s1 SL	12/09/2020	Monster	1	1	SL	340.8
2	1_s1 TNL 0-2	12/09/2020	Monster	1	1	TNL 0-2	469.7
3	1_s1 TNL 2-10	12/09/2020	Monster	1	1	TNL 2-10	464.9
4	1_s1 TNL 10-20	12/09/2020	Monster	1	1	TNL 10-20	489.2
5	1_s2 SL	12/09/2020	Monster	1	2	SL	447.8
6	1_s2 TNL 0-2	12/09/2020	Monster	1	2	TNL 0-2	429.5
7	1_s2 TNL 2-10	12/09/2020	Monster	1	2	TNL 2-10	436.6
8	1_s2 TNL 10-20	12/09/2020	Monster	1	2	TNL 10-20	rocky - no sample
9	1_s3 SL	12/09/2020	Monster	1	3	SL	308.4
10	1_s3 TNL 0-2	12/09/2020	Monster	1	3	TNL 0-2	rocky - no sample
11	1_s3 TNL 2-10	12/09/2020	Monster	1	3	TNL 2-10	rocky - no sample
12	1_s3 TNL 10-20	12/09/2020	Monster	1	3	TNL 10-20	rocky - no sample
.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.
665	17_s7 SL	07/07/2020	Glapsides	17	7	SL	320.2
666	17_s7 TNL 0-2	07/07/2020	Glapsides	17	7	TNL 0-2	346.8
667	17_s7 TNL 2-10	07/07/2020	Glapsides	17	7	TNL 2-10	354.1
668	17_s7 TNL 10-20	07/07/2020	Glapsides	17	7	TNL 10-20	352.5
669	17_s8 SL	07/07/2020	Glapsides	17	8	SL	284.4
670	17_s8 TNL 0-2	07/07/2020	Glapsides	17	8	TNL 0-2	265.5
671	17_s8 TNL 2-10	07/07/2020	Glapsides	17	8	TNL 2-10	241.7
672	17_s8 TNL 10-20	07/07/2020	Glapsides	17	8	TNL 10-20	274.2
.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.

* SL: strandline, TNL: turtle nesting line. Numbers denote sample depth in cm.

Ten equidistant sampling points were determined along the length of each beach parallel to the shoreline (Figure 2). At each sampling point, one 250 cm^3 sample was collected along the strandline (SL), and three 250 cm^3 samples were collected at incremental depths of 0-2, 2.1-10, 10.1-20 cm at the turtle nesting line (TNL). SL was characterised by the highest line of debris left behind from retreating tide, and TNL was characterised as a transect through the typical turtle nesting area on a given beach. All sediment samples from SL and TNL were collected using a bespoke steel cylindrical corer, 30 cm in length and 20 cm in diameter, with 2 cm incremental depth markings (Figure 3), and air-dried in aluminium trays covered with aluminium foil before analysis.

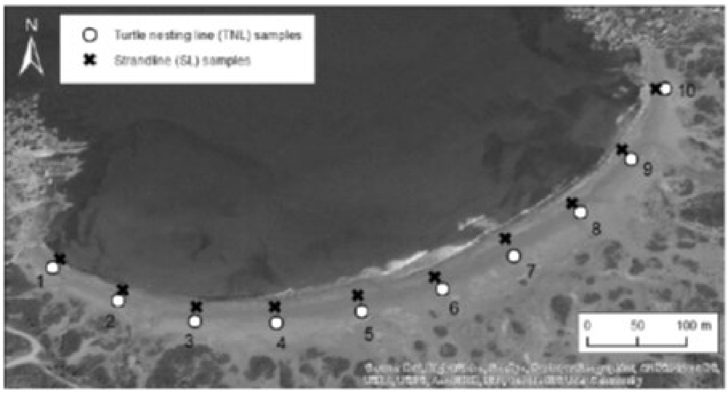

Figure 2. Experimental design of beach sediment sampling: 10 paired samples taken along the turtle nesting line (¡) and strandline (x), plotted using GPS locations of samples taken on beach 5.

Figure 3. Steel corer used for sediment collection and three samples collected at the turtle nesting line. Bafra beach, Northern Cyprus, July 2020.

Each dry sediment sample was weighed to 0.1 g (Kern EMB 220-1 balance) and passed through a 5 mm and 1 mm sieve cascade to obtain an aggregate of particles sized between 1-5 mm. Aggregates of each sample was stored separately. The aggregate needs to be further analysed for microplastic content and weight, and identification of plastic polymer types – however, this was not possible because partner laboratories were closed due to the pandemic.

Next steps to be taken to complete analysis:

The samples are available at University of Exeter and could be further analysed to complete this study. For each of the sediment sample aggregates, plastics will be separated from natural debris and classified into five categories based on visual sorting; Industrial, Foamed, Fragment, Sheet-like, and Thread-like as in Van Franeker et al. (2011). In this way, five subsamples will be obtained for each collected sediment sample aggregate. For each subsample, microplastics in each category will be counted and weighed to 0.0001g.

II. Impacts of plastic pollution on sand temperature

Marine turtles are inherently reliant on the sand temperature due to temperature dependent sex determination. Any change in the sand surrounding the nests will result in a change in the physical environment that the hatchlings experience during their development in the egg. If this change in the nest environment is dramatic enough to lead to a change in the incubation temperature, this is likely to affect offspring sex ratios and/or hatching success. One such potential disturbance to the life cycle of marine turtles is plastic pollution on nesting beaches.

We designed field protocols to identify any effect that plastic pollution may have on the incubation temperature of marine turtle nests through in-situ experiments in Northern Cyprus The protocols were designed to evaluate the change in sand temperature at nest depth with different levels of macroplastic pollution (on sand surface) and microplastic pollution (particles mixed within the sand column).

Tinytag temperature loggers were used throughout this study (cofounded by SPOT; Tinytag Plus 2 TGP-4017, Gemini Data Loggers). These data loggers have a resolution of 0.01°C and an accuracy of ±0.4°C for the temperature range of -40°C to +85°C, within which our experiments were conducted. The in-situ experiments were conducted on Alagadi 1 beach (Figure 1; beach number 4) in Northern Cyprus.

Five rectangular plots of 5m x 5m dimensions were marked out on the beach. The plots were at least 5 m apart and were equidistant from the shoreline, as measured from edge to edge. The plots were cleaned of any pre-existing surface debris. Plots (Figure 5) were defined as:

1) *Clean*: control plot with no plastic pollution on the surface
2) *Beach plastics*: plot covered with light coloured plastics collected from beaches
3) *White sheet*: plot covered with a white plastic sheet
4) *Black sheet*: plot covered with a black plastic sheet
5) *Perfect*: plot cleaned of all plastics by digging to a depth of 45 cm, all removed sand was cleaned of microplastics by running through a 1 mm sieve, and the clean sand was put back.

Thirteen temperature loggers were placed in each plot at a 45 cm depth as shown in Figure 4. The temperature loggers were set to record the ambient temperature every hour and were retrieved after two weeks of data collection.

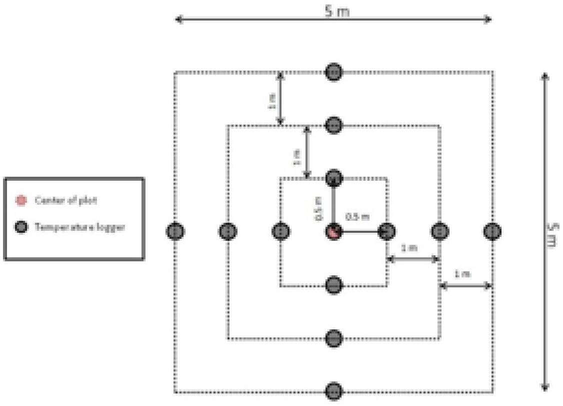

Figure 4. Placement of temperature data loggers in a 5m x 5m plot at 45 cm depth.

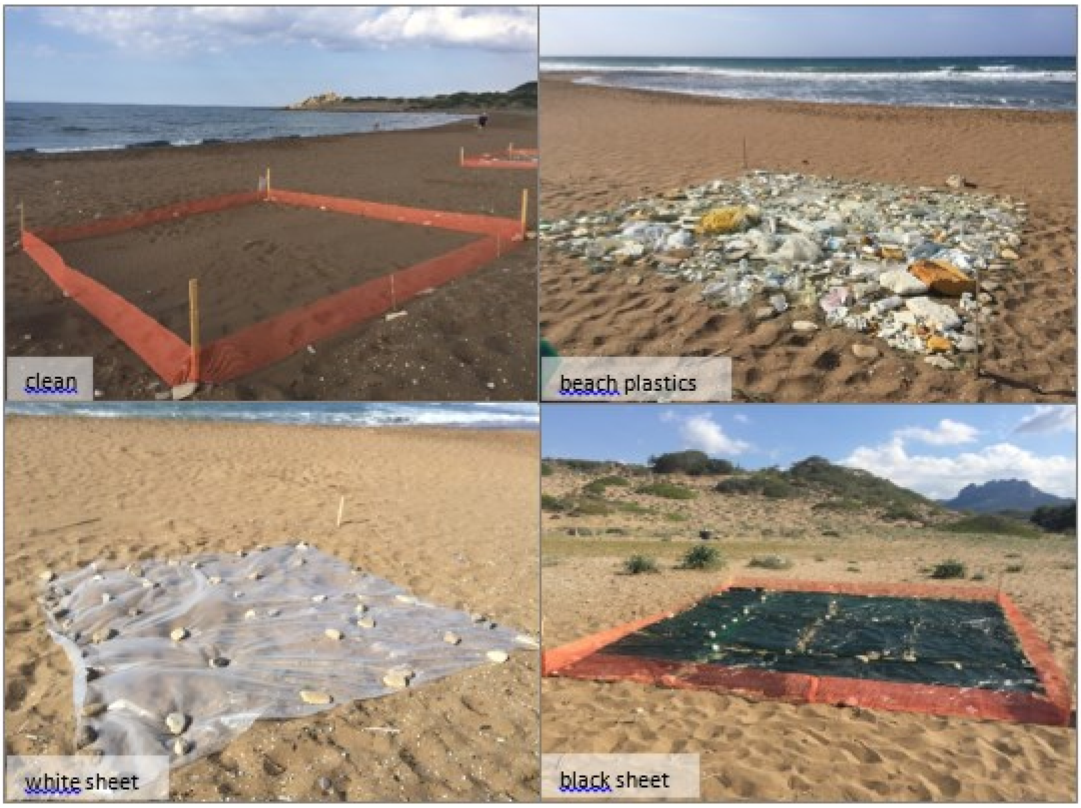

Figure 5. Experimental plots for testing the effects of various macroplastic types at Alagadi beach, northern Cyprus.

Experiment results

Results suggest that beach plastics have a cooling effect on the sand and the incubation temperature for the turtles. The plot that was covered in beach plastics had a lower temperature than the plot that was left natural (Figure 6). It was also observed that white sheet plastics increased the temperature of the sand as much as 2℃.

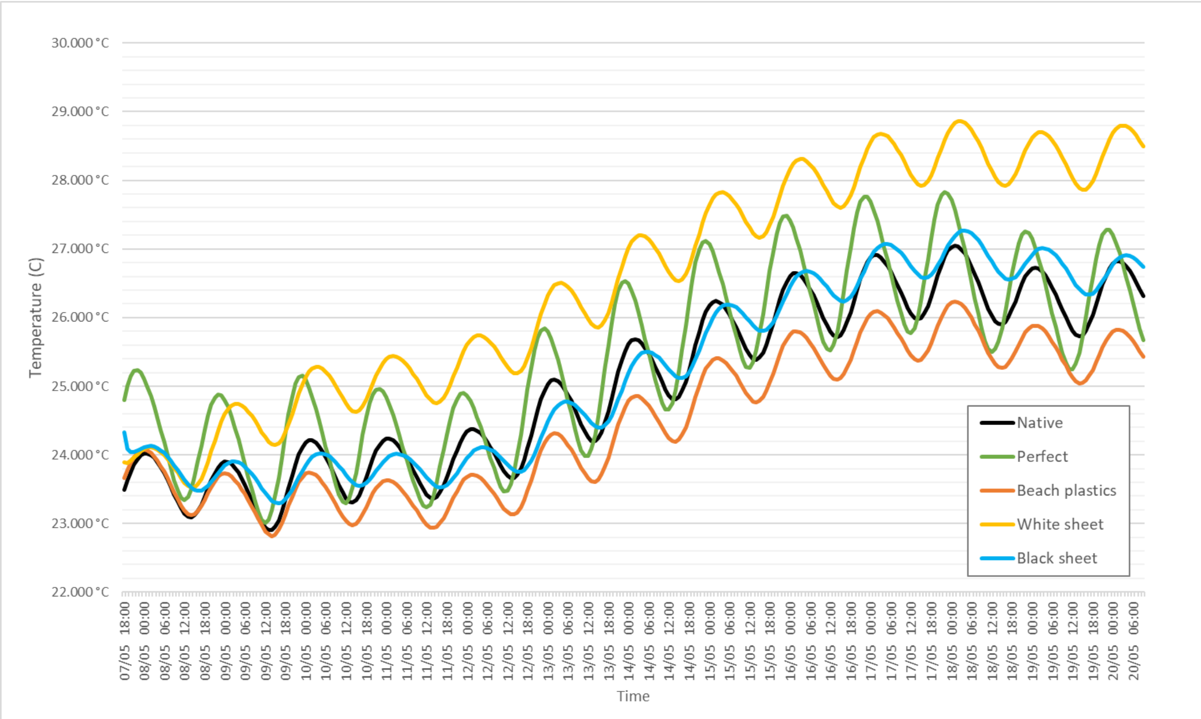

Figure 6. Temperature of center loggers in each 5x5 plot.

The result that beach plastics have a cooling effect on nests are interesting since sea turtle sex ratios are already considered female biased due to climate change. Thus, in many scenarios a cooling of nests would be considered a positive step in addressing female biased sex rations and reduced hatching success trough climate change driven increasing trajectories in incubation temperatures. Clearly though, leaving beach plastics in situ rather than clearing them is not the solution, since beach plastics also have many other negative ecological effects, including obstructing and entangling nesting females and hatchlings.

III. Beach cleaning activities

In 2020, more than 3 tonnes of plastic marine litter was collected during eight beach cleans, with a total of 2km of shoreline cleaned (Table 3). Most plastic was cleaned from Akdeniz beach (Monster) with a total of 818kg plastic collected, but the most polluted beach was “Ronnas 5”, with 665kg plastic collected from just 125m of the shoreline.

Table 3. Beach cleans completed in summer 2020, northern Cyprus.

	Date	Beach name	Number of volunteers	Weight of plastics collected (kg)	Distance cleaned (m)
1	08.05.2020	Mersinlik	17	150.5	885.2
2	08.05.2020	Kantara	17	106.22	152.08
3	19.05.2020	Akdeniz	45	818.42	1000
4	01.06.2020	Ronnas 5	23	665.72	125

5	05.06.2020	Ronnas 1	50	460	330
6	07.06.2020	Yeşilırmak	25	230	1025
7	27.06.2020	A1 and A2	40	191.1	1020
8	18-20 July 2020	Ronnas	28	571.42	500
		Total	**245**	**3193.38**	**2045**

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