

Final Report on microplastic research completed in Canaveral National Seashore under permit CANA-2019-SCI-0002

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Introduction

Few studies have examined microplastic pollution in Canaveral National Seashore and these have focused on very few samples. To understand and motivate change in behavior related to plastic use, it is necessary to first understand the distribution, abundance and type of microplastics which occur in a particular place. The purpose of this study, then is to begin to understand the seasonal dynamics of microplastic pollution in Canaveral National Seashore.

Methods

Two types of surveys were completed. The first type of survey is used to cover larger area and to engage user groups with the issue of microplastic pollution. These are 15-minute surveys where observers search for plastic pellets, also called nurdles. Samples were collected at four monitoring sites which were randomly selected from an initial pilot study. Due to access to the beach being through boardwalks, this study generally relied upon sampling starting from these entry points. The four monitoring sites were located north and south of parking lot 7, south of parking lot 5, and south of parking lot 4. Sampling occurred at least twice a year, corresponding to pre and post hurricane season (May/June and Dec/Jan). Two additional monitoring events occurred just after significant storms in Sep 2020 and Nov 2021. It became apparent that storm events could be impacting the number of nurdles washing on shore and thus these additional monitoring dates were opportunistically sampled. Sampling occurred at other sites (Appendix 1) opportunistically.

The second method samples for all microplastics by sieving five 50cm x 50 cm x 5 cm deep quadrats through a 5 mm and 1mm sieve and then recording all types of microplastics encountered on two 100 metre long transects laid at Playalinda. Transect 1 was sampled between parking lots 1 and 2 and transect 2 between parking lots 5 and 6. The remaining sand and plastics were sorted under a dissecting microscope and plastic sorted into fibers, film, foam, fragments, and nurdles. Sampling occurred in May 2019, Dec 2019, June 2020, Dec 2020 and May 2021.

Results

Nurdle Hunts

A total of 92 nurdle hunts (23 hours total search time) were conducted with the vast majority occurring within the Playalinda portion of the Seashore (88%). This was primarily due to the Principal Investigator residing in Titusville and monitoring sites located at Playalinda which were repeatedly sampled.

Appendix 1 lists all sample dates and sites along with the number of surveyors and number of nurdles

found. The number of nurdles found per 15-minute search ranges from 0 to 330 (mean $\pm$ 1 S.E. = 22.5 $\pm$ 9.6) and the number of surveyors ranged from 1 to 9. The number of surveyors was not significantly correlated with the number of nurdles found ($r(90) = -0.16$, $P > 0.05$).

Nurdles surveys were completed at the four monitoring sites on eleven occasions (Table 1 and Figure 1). Mean nurdle abundance ranged from 0 to 94.5. Nurdle abundance was highest for the two monitoring dates just after storms and were always higher post-hurricane season than pre-hurricane season. There was more variability in post-hurricane sampling than pre-hurricane. Surveys pre-hurricane resulted in mostly zero observations, with one nurdle found in one survey out of four in each of the monitoring dates.

Table 1: Mean nurdle abundance and standard error at monitoring sites in Playalinda by sampling date.

	mean	SE
Jan 18	39.5	11.2
Jun 18	0.25	0.25
Jan 19	1.5	0.6
May 19	0.25	0.25
Sep 19	94.5	17.2
Jan 20	17.3	6.7
Jun 20	0	0
Dec 20	2.25	1.3
May 21	0.25	0.25
Nov 21	49	21.8
Dec 21	3.5	1.4

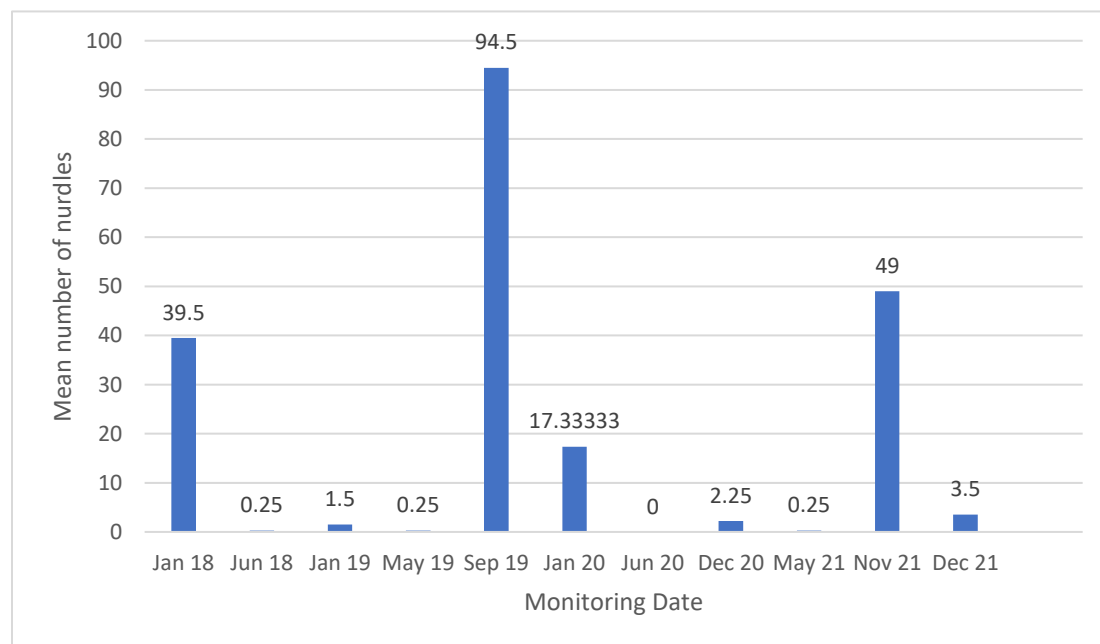


Figure 1: Mean nurdle abundance at monitoring sites in Playalinda by sampling date.

Spatial patterns within Canaveral National Seashore were not evident, though sampling was confounded temporally. Large-scale patterns between Apollo (n=7), Klondike (n=4), and Playalinda (n=81) were not attempted due to unequal sample sizes. Nurdle abundance was highest at sampling just after storms, then post-hurricane season and least abundance pre-hurricane season (Table 2).

Table 2: Nurdle abundance by sampling season

	mean	se	n
pre hurricane season	1.2	0.54	38
post hurricane season	31.5	8.15	46
storm event	71.8	15.44	8

Half of the data were from monitoring sites, including all samples taken during the storm events. However, the greater abundance during post-hurricane season surveys than pre-hurricane surveys was also observed when monitoring sites were removed from the analysis (Table 3).

Table 3: Nurdle abundance by sampling season without monitoring sites

	mean	se	n
pre hurricane season	2.0	0.92	22
post hurricane season	47.8	14.49	24

Microplastic sampling

Over the five sampling sessions, a total of 92 microplastic pieces were found in samples. The majority of these were foam and fragments (Figure 2).

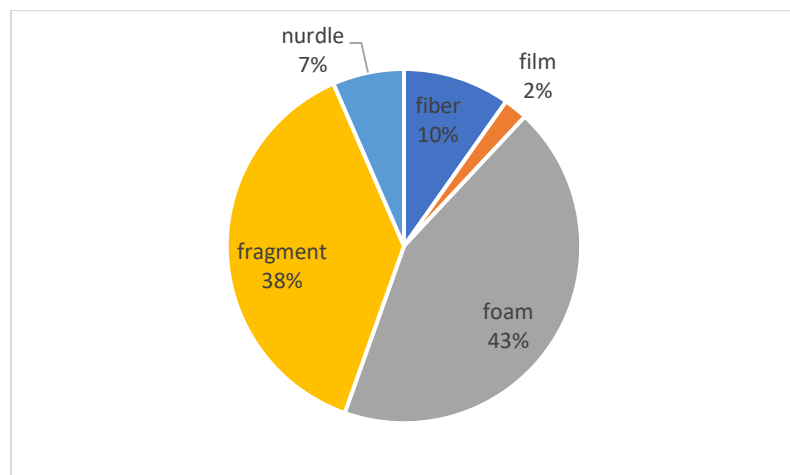


Figure 2: Percent of microplastic pieces (n=92) by category.

When the sampling was characterized by pre- and post-hurricane season (ie. May/June vs Dec), there were differences in the percentage of the microplastic categories. The main difference being the relative abundance of foam and fragments as a percent of plastic pieces (Figure 3).

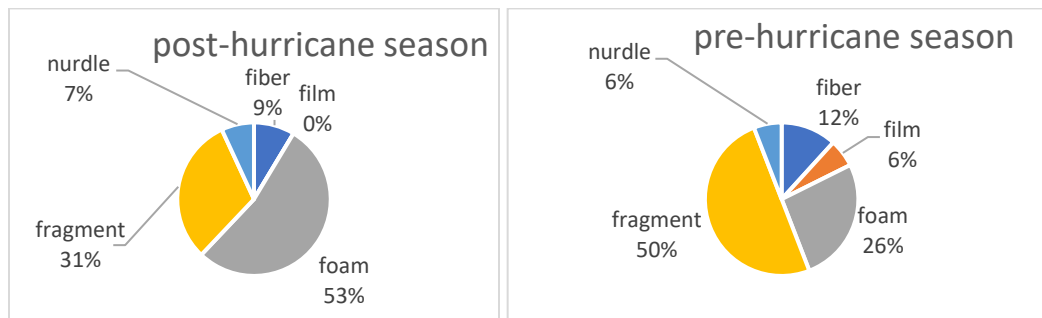


Figure 3: Percent of microplastic pieces by category

The total number of microplastic pieces was influenced by the presence of a large number ($n=20$) of foam pieces found in one transect in Dec 2020 (Table 4). Preliminary analysis using ANOVA indicated no significant differences in the mean number of plastic pieces found by season.

Table 4: mean number of microplastic pieces found per sampling season based on two transect per season.

	mean	se
May-19	5	3
Dec-19	5.5	0.5
Jun-20	4	2
Dec-20	23.5	16.5
May-21	5	0

Discussion/Conclusion

Similar sampling occurred at sites near Cocoa Beach and results await formal statistical evaluation and comparison to Cocoa Beach sites. However, for CANA, there appear to be several conclusions and some obvious directions for future work and collaboration.

- Temporal rather than spatial variability appears to be most important for nurdle abundance. This indicates that data needs to be collected within a relatively short sampling window for spatial comparisons and that the impact of storms needs to be considered in any data analysis.
- Nurdle hunts were useful for non-scientists to participate. Over the course of the study, students from elementary, junior high, high school, university, and non-students were involved in the data collection. Additionally, public engagement through individuals asking questions about what we were doing was useful in sensitizing the public to microplastic pollution.
- Preliminary analysis of records of plastic manufacturers in Florida and known routes for microplastics to wash up on CANA beaches indicate that microplastics sources are primarily oceanic. Plastic is left on the beaches by users, indicated by beach cleans, but it is unlikely that this is not a main source of microplastic pollution. Solutions to microplastic washing up on CANA beaches thus remains a global and regional issue of stopping the tap of plastic entering the ocean.
- Scientific sampling for microplastics took significant time and effort. Usually, two full days were necessary to collect and sieve the sand samples with an additional 1-2 days for sorting microplastics from the samples. Scientific interns were trained in microplastic procedures that are transferrable and these were a useful tool for teaching on this issue, but ongoing monitoring is not likely to produce data which management can act upon locally.

- There are significant opportunities for A Rocha and NPS CANA to collaborate on educational events, particularly as A Rocha has recently received funding for three 9-month interns starting in Fall 2022 and then again in Fall 2023. Additionally, we would be happy to work with any communications staff on social media posts related to microplastics.

Future plans

- It appears that temporal variability is more important than spatial variability at sites in CANA. An extensive sampling effort over a short temporal period and wide spatial area is necessary to make this conclusion more firmly. This sampling should not be based on access points but generated randomly.
- The role of hurricanes needs to be investigated systematically.
- Nurdle monitoring should continue to develop a long-term baseline for future studies. Microplastics monitoring is unlikely to be continued, but used to periodically determine percent category of microplastics and train scientists in this technique.
- Development and testing of a simpler, quicker method of sampling microplastics which yields accurate information and could be used as a citizen science event.
- It will be important to begin to study any ecological impacts of microplastics, particularly through the food chain. Additionally, to determine possible ecological vectors of microplastics from the CANA beaches to the Indian River Lagoon.
- Baseline understandings of beach geomorphology could also be important in better understanding potential impacts of microplastics. A Rocha is collaborating with Dr Angela Witmer of Palm Beach Atlantic University in this context.



Appendix 1 – Sample sites

Date	Location	Surveyors	Nurdles
12/17/2021	Playalinda 7 going south from crossover to beach – monitoring site	1	3
12/17/2021	Playalinda 7 going north from crossover to beach – monitoring site	1	4
12/18/2021	Playalinda 4 going south from crossover to beach– monitoring site	1	7
12/18/2021	Playalinda 5 going south from crossover to beach – monitoring site	1	0
11/11/2021	Playalinda 7 going south from crossover to beach – monitoring site	2	29
11/11/2021	Playalinda 7 going north from crossover to beach – monitoring site	2	8
11/11/2021	Playalinda 4 going south from crossover to beach– monitoring site	2	50
11/11/2021	Playalinda 5 going south from crossover to beach – monitoring site	2	109
5/13/2021	Playalinda 7 going south from crossover to beach – monitoring site	4	0
5/13/2021	Playalinda 7 going north from crossover to beach – monitoring site	4	0
5/13/2021	Playalinda 4 going south from crossover to beach– monitoring site	6	1
5/13/2021	Playalinda 5 going south from crossover to beach – monitoring site	6	0
12/7/2020	Playalinda 7 going south from crossover to beach – monitoring site	2	1
12/7/2020	Playalinda 7 going north from crossover to beach – monitoring site	2	2
12/7/2020	Playalinda 4 going south from crossover to beach– monitoring site	2	6
12/7/2020	Playalinda 5 going south from crossover to beach – monitoring site	2	0
11/17/2020	Playalinda 4 going south from crossover to beach– monitoring site	1	4
11/17/2020	Playalinda 5 going south from crossover to beach – monitoring site	1	3
6/15/2020	Playalinda 7 going south from crossover to beach – monitoring site	4	0
6/15/2020	Playalinda 7 going north from crossover to beach – monitoring site	4	0
6/15/2020	Playalinda 4 going south from crossover to beach– monitoring site	2	0
6/15/2020	Playalinda 5 going south from crossover to beach – monitoring site	2	0
3/1/2020	Playalinda Car Park 1 south	9	14
1/30/2020	Playalinda 7 going south from crossover to beach – monitoring site	3	30

1/30/2020	Playalinda 5 going south from crossover to beach – monitoring site	3	15
1/30/2020	Playalinda 7 going north from crossover to beach – monitoring site	3	7
1/30/2020	Playalinda 4 going south from crossover to beach– monitoring site	2	57
1/29/2020	Playalinda Eddy creek north of entrance	2	33
1/29/2020	Playalinda Eddy creek south of entrance	2	15
1/24/2020	Playalinda car park 12 north	3	330
1/24/2020	Playalinda Eddy creek north of entrance	3	141
1/24/2020	Playalinda Car Park 1 south	2	112
1/2/2020	Eddy creek	8	0
11/16/2019	Playalinda Car Park 10	1	82
11/16/2019	Playalinda Car Park 6	1	51
11/16/2019	Playalinda Car Park 3	1	47
11/16/2019	Playalinda Car Park 1	1	14
11/15/2019	Playalinda Car Park 1	1	0
11/12/2019	Playalinda Car Park 1	4	6
9/21/2019	Playalinda 11 south of crossover to beach	1	73
9/21/2019	Playalinda 11 north of crossover to beach	1	45
9/6/2019	Playalinda 4 going south from crossover to beach– monitoring site	2	144
9/6/2019	Playalinda 5 going south from crossover to beach – monitoring site	2	74
9/6/2019	Playalinda 7 going north from crossover to beach – monitoring site	1	91
9/6/2019	Playalinda 7 going south from crossover to beach – monitoring site	1	69
5/27/2019	Playalinda South of #1	6	1
5/27/2019	Playalinda South of #1	4	0
5/26/2019	Apollo Beach # 4 north	6	0
5/26/2019	Apollo Beach # 3 south	6	0
5/26/2019	Apollo Beach # 3 north	6	0
5/26/2019	Apollo Beach # 4 south	5	0
5/26/2019	Apollo Beach # 4 north	5	0
5/15/2019	Playalinda #5 South – monitoring site	5	1
5/15/2019	Playalinda #4 South – monitoring site	5	0
5/15/2019	Playalinda parking lot 7 north of access point – monitoring site	3	0
5/15/2019	Playalinda parking lot 7 south of access point – monitoring site	2	0
5/15/2019	Playalinda #1 South	5	1
5/15/2019	Playalinda parking lot 8 south of access point	4	0
5/15/2019	Playalinda parking lot 11 north of access point	2	0
5/15/2019	Playalinda parking lot 12 north of access point	2	0
5/15/2019	Playalinda parking lot 10 south of access point	2	0
5/15/2019	Playalinda parking lot 9 south of access point	2	0
1/31/2019	Playalinda parking lot 4 south of access point – monitoring site	3	3

1/31/2019	Playalinda parking lot 7 south of access point – monitoring site	3	2
1/31/2019	Playalinda parking lot 5 south of access point – monitoring site	3	1
1/31/2019	Playalinda parking lot 7 north of access point – monitoring site	3	0
8/23/2018	Apollo Beach parking lot 5 north of entrance	3	0
8/23/2018	Apollo Beach parking lot 5 north of entrance	3	0
6/25/2018	Playalinda parking lot 11 north of entrance	2	2
6/25/2018	Playalinda parking lot 9 south of entrance	2	2
6/19/2018	Playalinda parking lot 4 south of access point – monitoring site	1	1
6/19/2018	Playalinda parking lot 7 north of access point – monitoring site	1	0
6/19/2018	Playalinda parking lot 7 south of access point – monitoring site	1	0
6/19/2018	Playalinda parking lot 5 south of access point – monitoring site	1	0
4/21/2018	Klondike Beach	5	12
4/21/2018	Klondike Beach	5	11
4/21/2018	Klondike Beach	5	0
4/21/2018	Klondike Beach	5	0
1/27/2018	Playalinda parking lot 7 north of access point – monitoring site	2	42
1/27/2018	Playalinda parking lot 7 south of access point – monitoring site	1	27
1/21/2018	Playalinda parking lot 4, south of access point – monitoring site	3	70
1/21/2018	Playalinda parking lot 4, north of access point	3	84
1/9/2018	Playalinda parking lot 5, south of boardwalk – monitoring site	1	19
1/9/2018	Playalinda parking lot 6, north of boardwalk	1	25
1/9/2018	Playalinda parking lot 6, south of boardwalk	1	21
1/9/2018	Playalinda parking lot 5, north of boardwalk	1	18
12/28/2017	Playalinda parking lot 3, north of boardwalk	1	10
12/28/2017	Playalinda parking lot 3, south of boardwalk	1	9
12/26/2017	Playalinda parking lot 2, south of boardwalk	2	16
12/26/2017	Playalinda parking lot 2, north of boardwalk	2	7
12/24/2017	Playalinda parking lot 1, north of boardwalk	1	9
12/24/2017	Playalinda parking lot 1 south of boardwalk	1	0