Supporting Information

What type of plastic do sea turtles in Korean waters mainly ingest? Quantity, shape, color, size, polymer composition, and original usage

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S1. Turtle biometrics

Of the 34 turtles, 27 were females, 3 were males and 4 were juveniles of indeterminate sex. Likewise, most of the turtles of each species were females: 18 loggerheads, 6 greens, 1 olive ridley, and 2 leatherbacks. The mean CCL, SCL, and weight of each species were as follows: 79.3 ± 9.6 (42–91) cm CCL, 75.6 ± 8.7 (45.3–83.8) cm SCL, and 59.4 ± 14.9 (14.8–83.5) kg for loggerhead turtles (n = 21); 71.7 ± 17.6 (42.8–93.3) cm CCL, 65.2 ± 15.6 (40.3–79.5) cm SCL, and 41.8 ± 24.5 (8.9–70.5) kg for green turtles (n = 9); 65.7 ± 0.6 (65.1–66.2) cm CCL, 60.8 cm SCL (not available for one individual), and 27 ± 0.6 (26.4–27.5) kg for olive ridley turtles (n = 2); and 134 ± 4 (130–138) cm CCL, 125.5 ± 2.5 (123–128) cm SCL, and 196 ± 7.3 (189–204) kg for leatherback turtles (n = 2).

S2. Statistical analysis

Data analysis was conducted based on mass. However, some characteristics, such as original usage and size group (macro: > 25 mm, meso: 5–25 mm, micro: 1–5 mm) are presented on a number basis to avoid underestimation. Where appropriate, the results are presented in terms of both mass and number. All statistical analyses were conducted using R (version 4.0.2). Comparison of body weights across species (loggerheads and greens) was conducted with the Wilcoxon signed rank test. The exact Wilcoxon rank sum test was applied to test for the statistical significance of the differences in CCL, n/ind., g/ind., mg/kg, mg/CCL cm, weight by shape, and weight by color between loggerheads and greens. Pearson's correlation was performed to identify the association between CCL and ingestion quantities (mg/ind., mg/kg, n/ind.). Leatherbacks and olive ridleys were excluded from the statistical analysis owing to the small sample size. All values herein after the " ± " symbol are standard deviations.

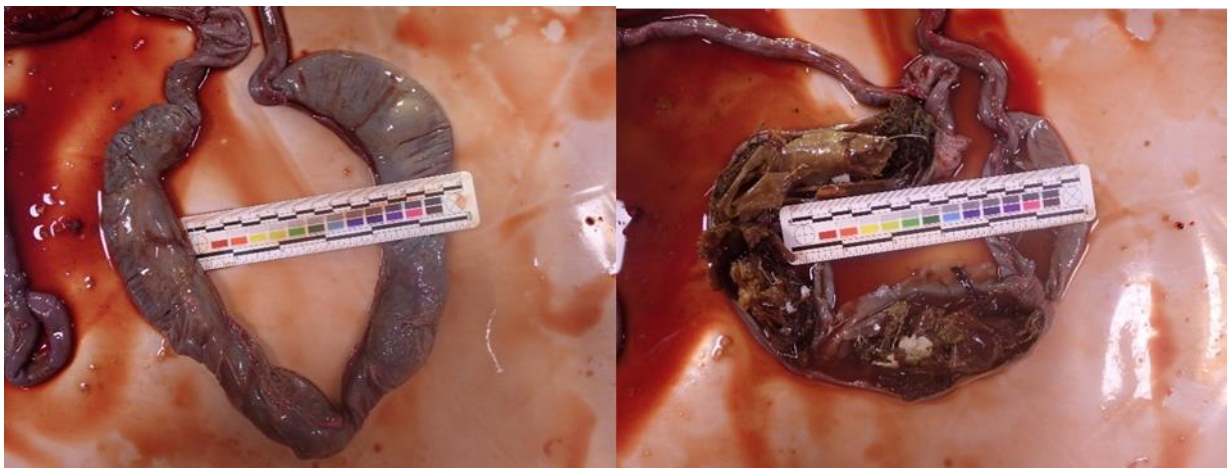

Figure S1 Photographs of the gastrointestinal tract of a loggerhead turtle (AR 38) before (left) and after incision (b). Photographs were provided by the National Institute of Ecology, South Korea.

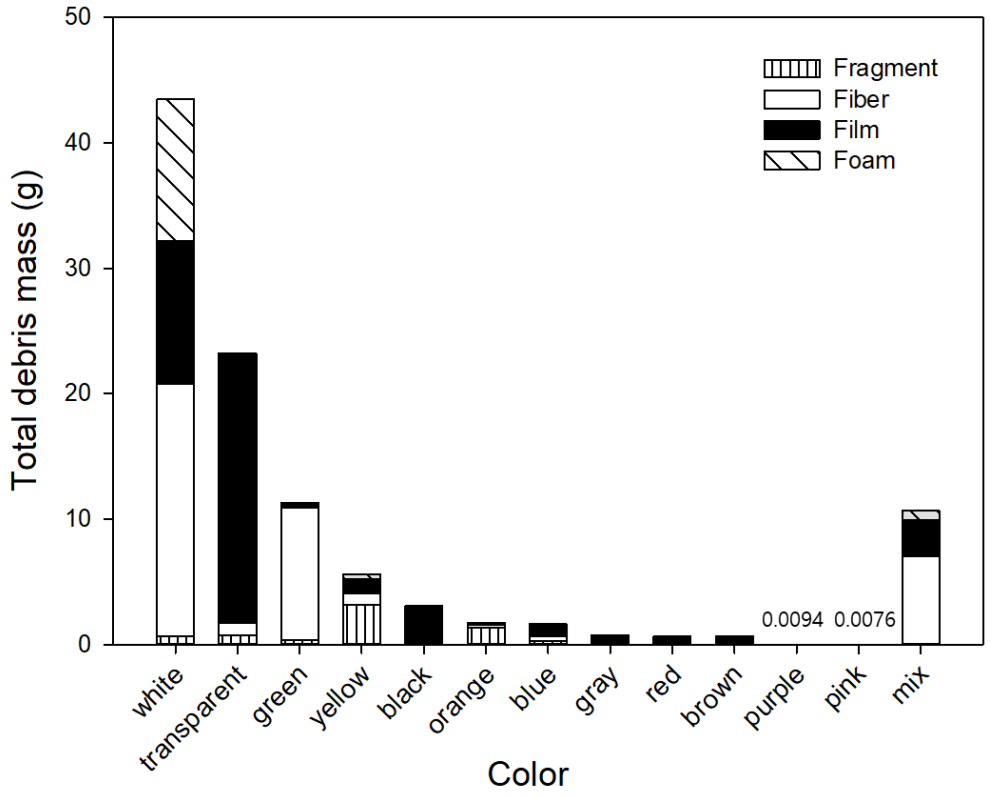

Figure S2 Shape composition of debris of different colors ingested by Korean coastal sea turtles. Data are total plastic mass by debris color.

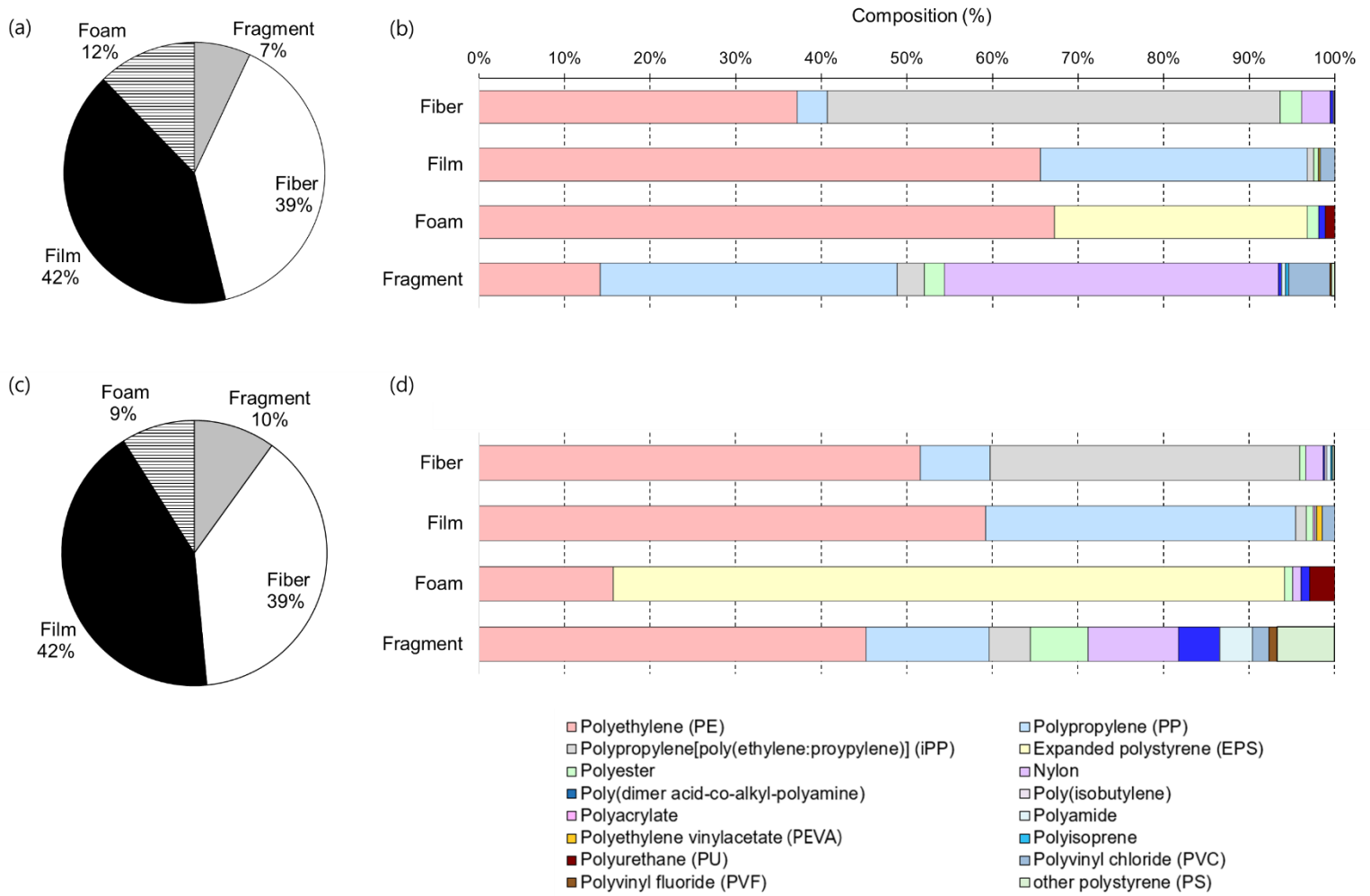

Figure S3 Composition of debris shapes based on mass (a) and the number of ingested plastics (c). Polymer composition of debris shapes based on mass (b) and the number of ingested plastics (d). The density of PE, PP, iPP, PS, polypropylene glycol monostearate, polyurethane, PEVA, poly(isobutylene) and poly(isoprene) was lower than that of sea water (specific density = 1.02 g/cm^3). The remaining polymers were heavier than sea water. The detail percentage of composition are provided in Table S3.

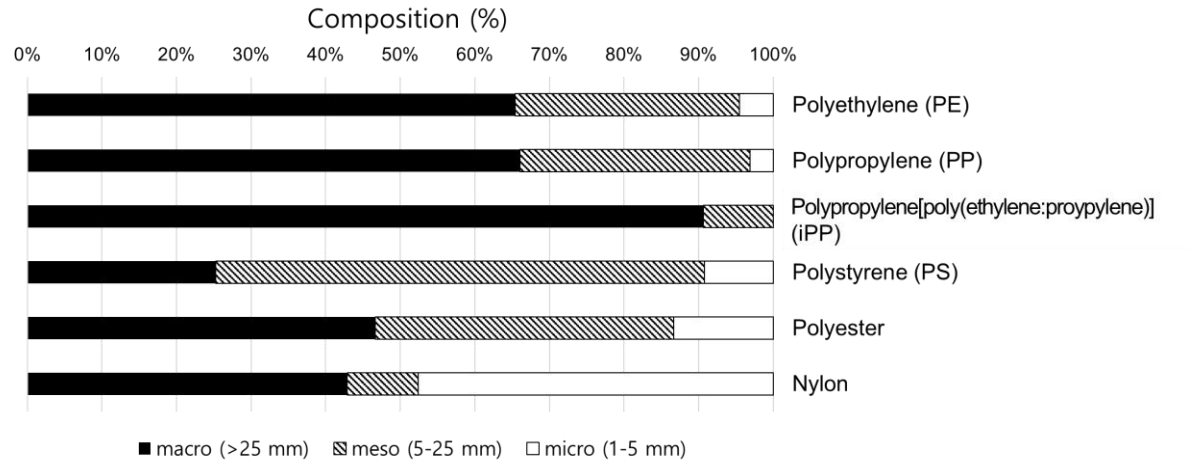

Figure S4 Size distribution of the six polymers most frequently ingested by Korean coastal sea turtles. Data are the percentage of total plastic pieces classified by size group for each polymer type (macro: > 25 mm, meso: 5–25 mm, micro: 1–5 mm).

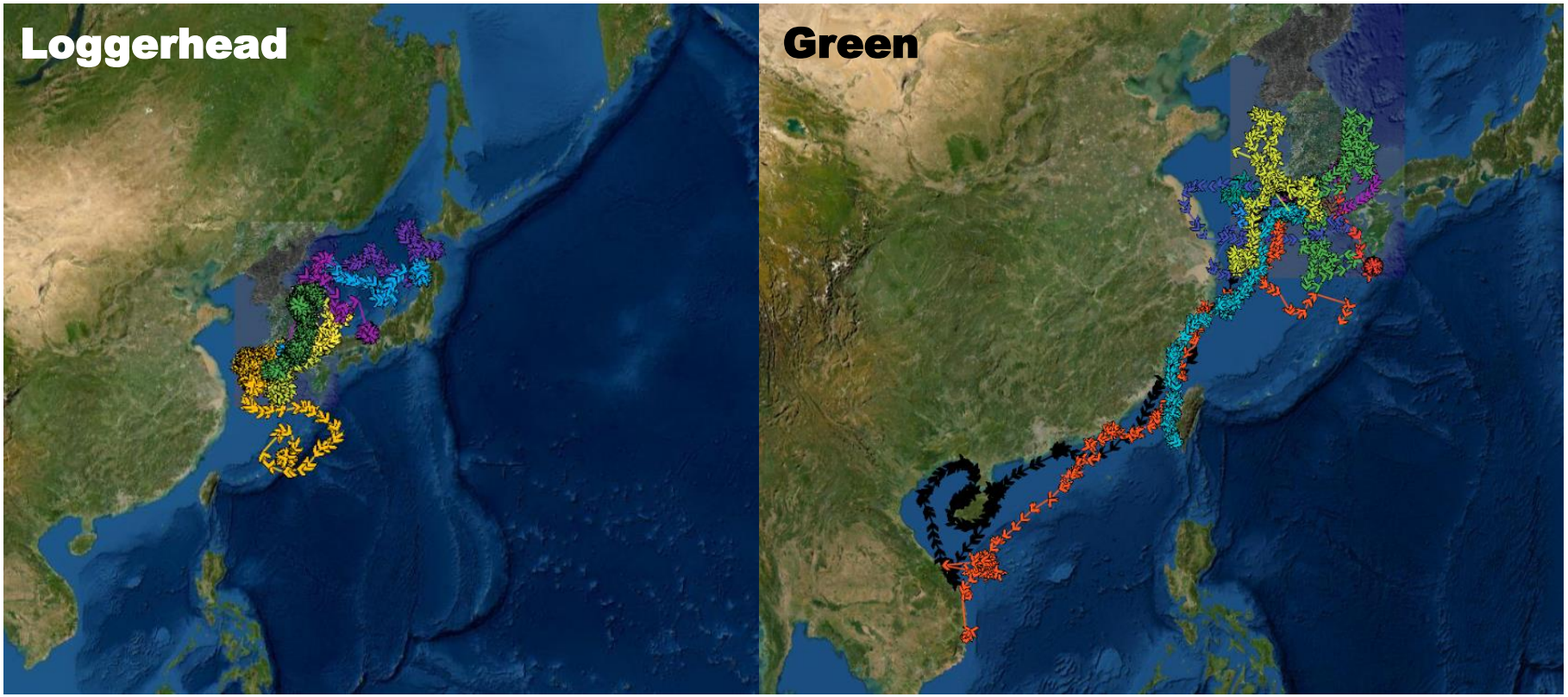

Figure S5 The route of movement of turtles (12 Loggerhead turtles, 22 Green turtles), released from Korean coast, with a satellite transmitter which were born in artificial incubator or rescued at Korean coastal waters. (Marine Bio Resource Information System (MBRIS, https://gis.mbris.kr/web/main.do#)

Table S1 Database of individual sea turtles stranded or bycaught in Korean coastal waters. The species are *Caretta caretta* (Cc), *Chelonia mydas* (Cm), *Lepidochelys olivacea* (Lo), and *Dermochelys coriacea* (Dc). Sex is categorized as female (F), male (M), and developing (D). Discovery status is classified as 'stranded (on beach)', 'floating (on sea)', and 'bycatch'. Some cases of incidental capture and abandonment by fishermen that caused the turtles to float or become stranded were reported. CCL = curved carapace length, SCL = straight carapace length, NA = not available

ID	Spec-ies	Capture date	Weight (kg)	CCL (cm)	SCL (cm)	Sex	n/ind.	Mean length of plastic (mm) / individual	Mass of plastic (mg) / individual	mg/kg individual	mg/cm CCL individual	mg/cm SCL individual	Discovery status
AR32	Cc	2015-08-09	82.9	91	83.8	F	0	0	0	0	0	0	Stranded
AR6	Cc	2016-08-25	NA	84.1	82.5	F	0	0	0	0	0	0	Floating
AR7	Cc	2016-09-16	57.7	81.2	76.4	F	18	117	2678	46.4	33	35	Stranded
Cc Disp.	Cc	2017-06-22	48.5	77	NA	F	57	59.9	4532	93.5	58.9	NA	Bycatch
AR9	Cc	2017-08-14	44.7	74.3	69.4	F	69	28.1	2931	65.6	39.4	42.2	Stranded
AR13	Cc	2017-09-22	47.6	78.2	73.5	M	2	62.5	27.9	0.6	0.4	0.4	Stranded
AR16	Cc	2017-10-16	53.3	78.2	74.3	F	3	241	370	6.9	4.7	5	Stranded
AR17	Cc	2017-10-17	63.9	81.7	76.3	F	3	70.3	33	0.5	0.4	0.4	Stranded
AR18	Cc	2017-10-19	69.1	86.2	83	M	11	197	4663	67.5	54.1	56.2	Stranded
AR19	Cc	2017-10-22	48.9	71	67.1	F	12	161	1172	24	16.5	17.5	Stranded
AR22	Cc	2017-10-28	61.7	82	78.4	F	0	0	0	0	0	0	Stranded
AR23	Cc	2017-10-28	65.8	82	80	F	9	59	352	5.4	4.3	4.4	Stranded
AR24	Cc	2017-11-21	58	82	68.8	F	5	144	623	10.7	7.6	9.1	Stranded
AR26	Cc	2017-12-14	74.2	85.7	82	F	4	22.3	191	2.6	2.2	2.3	Stranded
AR27	Cc	2018-05-31	68.3	84	79.7	F	22	28	1777	26	21.2	22.3	Floating
AR28	Cc	2018-06-03	64	83.2	79.6	F	10	49.9	181	2.8	2.2	2.3	Stranded
AR29	Cc	2018-06-10	57.1	75.8	72.2	F	21	117	5395	94.5	71.2	74.7	Stranded
AR30	Cc	2018-06-16	83.5	85.7	81.3	F	70	116	8355	100	97.5	103	Stranded
AR31	Cc	2018-06-21	72.1	86.1	81.9	F	52	78.2	15602	216	181	191	Bycatch
AR38	Cc	2018-09-09	14.8	42	45.3	D	221	36.9	10238	693	244	226	Stranded
AR40	Cc	2018-10-01	51.1	74.4	NA	F	0	0	0	0	0	0	Stranded
Total			59.4±14.9 [a] (14.8–83.5) [b]	79.3±9.6 (42–91)	75.6±8.7 (45.3–83.8)		28±48.6 (0–221)	75.6±66.3 (0–241)	2815±4047 (0–15602)	69.3±149 (0–693)	39.9±63 (0–244)	39.6±63 (0–226)	

Table S1 Continued

ID	Spec-ies	Capture date	Weight (kg)	CCL (cm)	SCL (cm)	Sex	n/ind.	Mean length of plastic (mm) / individual	Mass of plastic (mg) / individual	mg/kg individual	mg/cm CCL individual	mg/cm SCL individual	Discovery status
AR34	Cm	2012-07-28	10.2	44.9	44.5	D	170	70.9	13390	1313	298	301	Stranded
AR35	Cm	2012-07-28	8.9	42.8	40.3	D	111	34.3	2600	294	60.7	64.5	Stranded
AR33	Cm	2015-05-04	14.5	56.1	51.8	D	1	3	0.8	0.1	0	0	Stranded
AR10	Cm	2017-07-31	66.4	93.3	77.4	F	15	199	10462	158	112	135	Stranded
AR8	Cm	2017-08-01	58.9	83.7	78.5	F	51	77.2	1990	33.8	23.8	25.3	Stranded
AR15	Cm	2017-10-15	70.5	85	79.5	F	11	41.8	9297	132	109	117	Stranded
AR21	Cm	2017-10-26	52.8	79.4	73.9	F	22	139	4363	82.6	55	59	Stranded
AR36	Cm	2018-08-15	52.5	80	NA	F	79	74.5	5157	98.3	64.5	NA	Stranded
AR37	Cm	2018-08-19	NA	80.5	75.3	F	229	54.6	11700	NA	145	155	Bycatch
Total			41.8±24.5 (8.9–70.5)	71.7±17.6 (42.8–93.3)	65.2±15.6 (40.3–79.5)		76.6±75 (1–229)	77.1±55.6 (3–199)	6551±4499 (0.8–13390)	264±405 (0.1–1313)	96.4±83 (0–298)	107±88.8 (0–301)	
AR14	Lo	2017-09-28	27.5	65.1	60.8	F	2	19.7	19.7	0.7	0.3	0.3	Stranded
AR20	Lo	2017-10-24	26.4	66.2	NA	M	0	0	0	0	0	0	Stranded
Total			27±0.6 (26.4–27.5)	65.7±0.6 (65.1–66.2)	60.8		1±1 (0–2)	9.9±9.9 (0–19.7)	9.9±9.9 (0–19.7)	0.4±0.4 (0–0.7)	0.2±0.2 (0–0.3)	0.2±0.2 (0–0.3)	
Dc Disp.	Dc	2012-05-31	189	130	123	F	2	111	272	1.4	2.1	2.2	Stranded
AR39	Dc	2018-09-17	203.5	138	128	F	0	0	0	0	0	0	Stranded
Total			196±7.3 (189–204)	134±4 (130–138)	125.5±2.5 (123–128)		1±1 (0–2)	55.5±55.5 (0–111)	136±136 (0–272)	0.7±0.7 (0–1.4)	1.1±1.1 (0–2.1)	1.1±1.1 (0–2.2)	

[a] Average ± standard deviation
[b] (min-max)

Table S2 Colors of debris ingested by Korean coastal sea turtles by different species (Cc: loggerhead, Cm: green, Lo: olive ridley, Dc: leatherback). Data are based on both mass and number (presented with parenthesis).

Spec-ies	Color												
	White	Transpar-ent	Green	Yellow	Black	Orange	Blue	Gray	Red	Brown	Purple	Pink	Mix
Cc	10.4 (150)	17.7 (142)	2.20 (25)	3.75 (18)	2.15 (20)	0.14 (3)	1.09 (12)	0	0.06 (18)	0.44 (4)	0	0.01 (1)	5.63 (51)
Cm	32.1 (332)	5.56 (76)	9.11 (158)	1.84 (19)	0.95 (29)	1.58 (15)	0.52 (30)	0.73 (1)	0.61 (5)	0.14 (4)	0.01 (1)	0	5.8 (17)
Lo	0	0.02 (2)	0	0	0	0	0	0	0	0	0	0	0
Dc	0.27 (1)	0.01 (1)	0	0	0	0	0	0	0	0	0	0	0
Total	42.8 (483)	23.2 (221)	11.3 (183)	5.60 (37)	3.10 (49)	1.73 (18)	1.61 (42)	0.73 (1)	0.67 (23)	0.58 (8)	0.01 (1)	0.01 (1)	11.4 (68)
Total (%)	41.6 (42.3)	22.6 (19.4)	11.0 (16.0)	5.44 (3.24)	3.02 (4.29)	1.68 (1.58)	1.57 (3.68)	0.71 (0.09)	0.65 (2.02)	0.56 (0.70)	0.01 (0.09)	0.01 (0.09)	11.1 (5.96)

Table S3 Polymer composition by shape for ingested plastics based on weight and count. The graphs are provided in Figure S3.

	Shape composition (%)											
	Film		Fiber		Foam		Fragment					
Polymer type	Weight	Count	Weight	Count	Weight	Count	Weight	Count	Total weight (g)	Weight (%)	Total count (n)	Count (%)
Polyethylene (PE)	65.6	59.1	37.1	51.7	67.2	15.7	14.1	43.5	52.62	51.2	577	50.8
Polypropylene [poly(ethylene:propylene)] (iPP)	0.8	36.2	52.9	8.2	0	0	3.2	13.9	21.92	21.3	226	19.9
Polypropylene (PP)	31.2	1.2	3.5	36.3	0	0	34.7	4.6	17.19	16.7	171	15.1
Nylon	0	0.2	3.3	0	0	78.4	39.0	0	4.00	3.9	81	7.1
Expanded polystyrene (EPS)	0	0	0	2	29.5	1.0	0	10.2	3.72	4	21	1.9
Polyester (PES)	0.5	0.8	2.5	0.7	1.3	1.0	2.4	6.5	1.56	1.5	15	1.3
Polyvinyl chloride (PVC)	1.7	1.4	0	0	0	0	4.8	1.9	1.06	1	9	0.8
Poly (dimer acid-co-alkyl-polyamine)	0	0	0.4	0.2	0.7	1.0	0.4	4.6	0.28	0.3	7	0.6
Polyurethane (PU)	0	0	0	0	1.1	2.9	0	0	0.14	0.1	3	0.3
Polyethylene vinyl acetate (PEVA)	0.2	0.6	0	0	0	0	0	0	0.09	0.1	3	0.3
Polyamide (PA)	0	0.2	0.1	0.5	0	0	0.5	3.7	0.07	0.1	7	0.6
Poly(isobutylene)	0	0	0.1	0.2	0	0	0	0	0.03	0	1	0.1
Polystyrene (PS)	0	0	0	0.2	0	0	0.4	5.6	0.03	0	7	0.6
Polyisoprene	0	0	0	0	0	0	0.4	4.6	0.03	0	5	0.4
Polyacrylate copolymer	0	0.2	0	0	0	0	0	0	0.02	0	1	0.1
Polyvinyl fluoride (PVF)	0	0	0	0	0	0	0.2	0.9	0.01	0	1	0.1
Total									102.8	100	1135	100

Table S4 Polymer composition by original usage for ingested plastics based on weight and count (PE: polyethylene, PP: polypropylene, iPP: polypropylene [poly(ethylene:propylene)], PEVA: polyethylene vinyl acetate, PVC: polyvinyl chloride).

		Polymer composition (weight %)											
Origin	Shape	PE	PP	iPP	Polyester	Nylon	Poly (isobutylene)	PEVA	PVC	Total weight (g)	Weight (%)	Total count (n)	Count (%)
Rope	fiber	38.2%	1.72%	52.8%	7%	0%	0.33%	0%	0%	8.83	24.4%	21	11.2%
Plastic bag	film	97.1%	1.22%	0%	1.28%	0%	0%	0.41%	0%	8.72	24.1%	35	18.7%
Packaging	film	18.1%	71.3%	0.14%	1.35%	0%	0%	0%	9.12%	5.25	14.5%	36	19.3%
Mesh bag	fragment	0%	0%	0%	0%	100%	0%	0%	0%	2.65	7.3%	1	0.5%
Tape	film	13%	87.1%	0%	0%	0%	0%	0%	0%	2.67	7.4%	7	3.7%
Net	fiber	99.5%	0%	0.51%	0%	0%	0%	0%	0%	1.60	4.4%	29	15.5%
Twine	fiber	15.2%	0.66%	81%	0%	3.14%	0%	0%	0%	1.53	4.2%	34	18.2%
Fishing line	fiber	57.4%	0.00%	0%	0%	42.6%	0%	0%	0%	1.39	3.8%	5	2.7%
Glove	fragment	0%	100%	0%	0%	0%	0%	0%	0%	1.31	3.6%	1	0.5%
Bottle label	film	0%	100%	0%	0%	0%	0%	0%	0%	0.96	2.6%	4	2.1%
Leaflet	film	100%	0%	0%	0%	0%	0%	0%	0%	0.75	2.1%	1	0.5%
Packaging	foam	100%	0%	0%	0%	0%	0%	0%	0%	0.59	1.6%	13	7.0%
Total										36.24	100%	187	100%

Table S5 Average of the frequency of occurrence (%FO) and amounts of debris (g/kg) ingested by loggerheads and green turtles found in different regions. (Amount in Fukuoka et al. (2016), Ng et al. (2016) calculated from the supplemental material of Lynch (2018))

	Region	N turtles	%FO	g/kg	Reference
Loggerhead	Korea	21	81	0.0728	This study
	North Central Pacific	5	80	0.293	Clukey et al. (2017)
	Mediterranean Sea	155	71	0.094	Domènech et al. (2019)
	Japan	13	85	0.184	Fukuoka et al. (2016)
Green	Korea	9	100	0.264	This study
	North Central Pacific	10	90	1.74	Clukey et al. (2017)
	Japan	10	100	3.33	Fukuoka et al. (2016)
	Hong Kong	8	25	0.014	Ng et al. (2016)