SUPPLEMENTARY MATERIAL

Patterns of resource use in Loggerhead turtle (*Caretta caretta*) from the Southwestern Atlantic Ocean

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LIPID EXTRACTION EXPERIMENT

Given that the presence of lipids can alter $\delta^{13}C$ values (Post et al. 2007), an experiment was conducted to evaluate the effect of lipid extraction on $\delta^{13}C$ and $\delta^{15}N$ values of the samples. For the experiment, two subsamples of 10 specimens were used, separated into two groups. To ensure comparability between groups, the central scute layers corresponding to the same position in the sequence of sections obtained with the microtome were selected (Fig. S1). In the first group, the lipids were extracted with a chloroform/methanol solution (2:1) (~1.5 mL) (Medeiros et al. 2019); the second group, the control group, did not undergo any extraction process. The extraction procedure involved replacing the Chl:Met solution three times a day. After the last extraction, the samples were dried at 60°C for 24 h, followed by independent analysis of the C and N stable isotope ratios.

A paired Student's t-test was conducted to quantify and examine the differences between lipid-extracted and non-extracted scute samples, separately for $\delta^{13}C$ and $\delta^{15}N$ values, after checking the assumptions of normality and homoscedasticity using the Shapiro-Wilk and Levene tests, respectively. Statistical significance was set at the $\alpha = 0.05$. Any observed differences were evaluated for their biological relevance relative to established values commonly reported in stable isotope studies (1–1.5‰ for $\delta^{13}C$ and 3‰ for $\delta^{15}N$).

Statistical comparisons revealed no changes on $\delta^{13}C$ (Paired t test, $t9 = -2.10$, $P = 0.07$) and $\delta^{15}N$ (Paired t test, $t9 = -1.25$, $P = 0.24$) values between extracted and non-extracted subsamples (Table S1. Observed mean differences were minimal (<1‰ for both isotopes) and well below values generally considered biologically meaningful; consequently, only untreated samples were used in subsequent analyses.

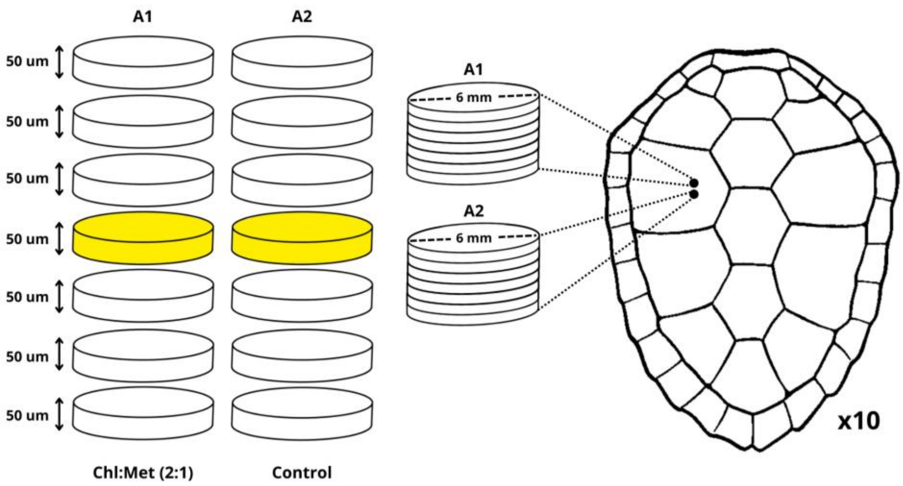

Figure S1. Schematic representation of the lipid extraction test. Two samples (A1 and A2) were obtained from the carapace scutes of 10 adult individuals. Each sample was sectioned into successive 50-µm layers, and the corresponding central layers (highlighted in yellow) were selected for stable isotope analysis (SIA), ensuring that they represented the same position within the sequence of layers. The layers of the test group were subjected to lipid extraction using a chloroform/methanol (Chl:Met) (2:1) solution, while the control group layers were not subjected to any treatment.

Table S1. Curved carapace length (CCL), C:N ratio, isotopic values of $\delta^{13}C$ and $\delta^{15}N$ of adult individuals of loggerhead turtles (*Caretta caretta*) in the Southwestern Atlantic Ocean (SWAO).

CCL (cm)	C:N non-extracted	C:N extracted	$\delta^{13}C$ (‰) non-extracted	$\delta^{13}C$ (‰) extracted	$\delta^{15}N$ (‰) non-extracted	$\delta^{15}N$ (‰) extracted
94	3.52	3.30	-15.72	-15.25	13.41	13.29
97	3.32	3.32	-14.89	-14.81	15.86	16.60
97	3.31	3.37	-15.64	-16.02	14.78	15.81
98	3.40	3.41	-14.88	-15.10	15.07	15.09
98	3.38	3.40	-15.34	-15.09	12.44	12.93
99	3.42	3.38	-15.56	-15.44	13.80	13.82
99	3.60	3.39	-18.78	-18.30	10.62	11.12
101	3.48	3.33	-14.85	-14.38	16.46	15.38
101	3.54	3.34	-15.24	-14.47	15.38	15.78
101	3.35	3.35	-15.94	-15.70	13.81	14.10

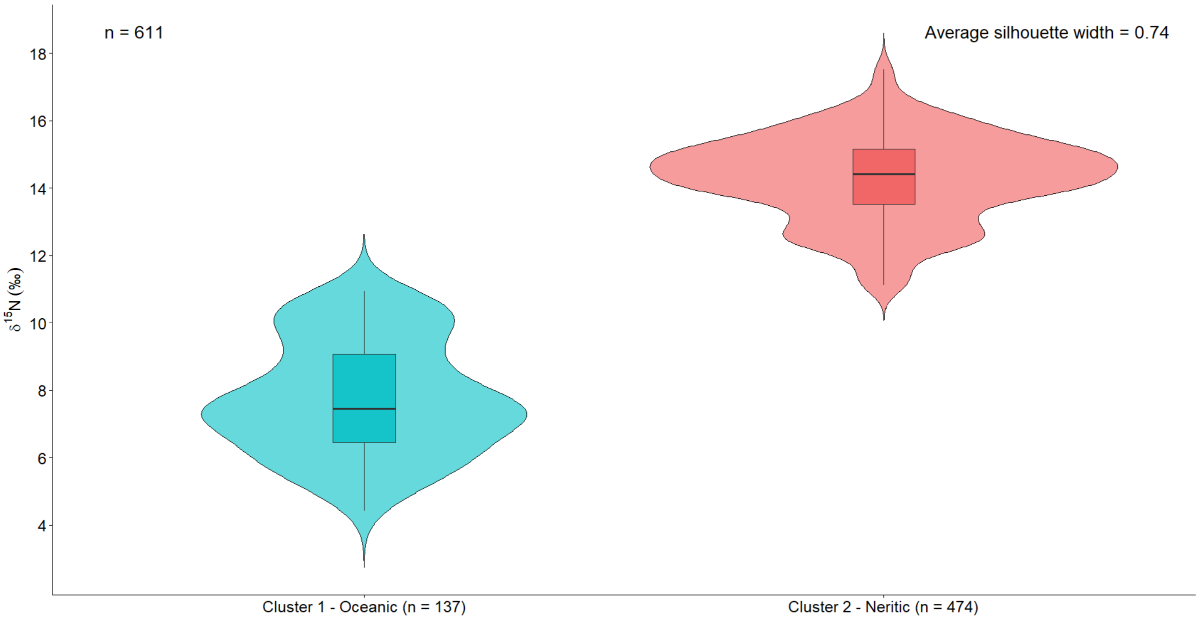

Figure S2. Distribution of $\delta^{15}N$ values for two clusters identified by *pam* partitioning algorithm. Violin plots show kernel density distributions, and boxplots indicate the median and interquartile range. Clusters were interpreted as oceanic (Cluster 1) and neritic (Cluster 2). Total sample size (n = 611) and average silhouette width (0.74) are shown in the figure

CRITERIA FOR THE CLASSIFICATION OF OCEANIC AND NERITIC INDIVIDUALS

The classification of loggerhead turtles (*Caretta caretta*) as oceanic or neritic individuals in this study was based on $\delta^{15}N$ isotopic profiles along successive scute layers, integrating cluster analysis of $\delta^{15}N$ values with regional isotopic baselines of potential prey and contextual information on capture and stranding locations.

Cluster analysis identified two well-defined isotopic groups, characterized by consistently lower and higher $\delta^{15}N$ values across scute layers (Fig. S2). These clusters were not interpreted solely as statistical groupings, but were evaluated in the context of known isotopic differences between pelagic and neritic food webs in the Southwestern Atlantic Ocean.

To support this interpretation, $\delta^{15}N$ and $\delta^{13}C$ values of potential prey consumed by loggerhead turtles in the region were compiled from Medeiros et al. (2019) and Leoni et al. (2024) (Table S3). Oceanic prey represented by salps exhibited low $\delta^{15}N$ values (mean ± SD: 4.95 ± 1.56‰), whereas neritic prey groups showed substantially higher $\delta^{15}N$ values (approximately 12–16‰), providing an independent isotopic baseline for distinguishing between oceanic and neritic foraging habitats.

Recruitment from oceanic to neritic habitat was defined as the first scute layer in which $\delta^{15}N$ values exceeded a threshold derived from the separation between the two isotopic clusters. Individuals exhibiting a clear increase in $\delta^{15}N$ values across successive layers were classified as shifters, reflecting a transition between foraging habitats over time.

In addition to isotopic profiles, the classification was supported by capture and stranding locations, which provided important contextual information on habitat use (Table S4). Among individuals classified as oceanic, three turtles were incidentally captured by pelagic longline fisheries off southern Brazil, indicating the use of oceanic habitats, while three others were found stranded along the coast. Of the stranded individuals, two were small turtles (CCAA, 24 cm CCL; CCZ, 29 cm CCL) that were likely debilitated and subsequently transported toward the coast prior to stranding, whereas the larger individual (CCR, 66.5 cm CCL) may have recently initiated recruitment into neritic habitats, as discussed in detail in the article. Shifter individuals were primarily found stranded along the Uruguayan coast (n = 5), with one individual incidentally captured by pelagic longline fishery, consistent with transitional foraging behavior. Most individuals classified as neritic were found stranded along the coasts of southern Brazil and Uruguay (n = 24), and two were incidentally captured in bottom pair trawl fishery, a coastal fishery that operates primarily at depths between 10 and 80 m (Haimovici 1997). Regional stranding data show that the mean CCL of stranded individuals differs significantly from those captured in pelagic longline fishery and is similar to those captured in bottom pair trawl fishery (Monteiro et al. 2016), supporting the association between coastal strandings and neritic habitat use. Consistent with this interpretation, Maruyama et al. (2024) demonstrated that turtles dying more than 50 km offshore have a minimal probability of stranding, indicating that coastal strandings primarily reflect individuals using neritic habitats prior to death.

Table S2. Mean ± standard deviation (SD) of δ^{13}C (‰) and δ^{15}N (‰) values of potential prey of loggerhead turtles (*Caretta caretta*) in the Southwestern Atlantic Ocean (SWAO), compiled from Medeiros et al. (2019) and Leoni et al. (2024). *n* = number of individuals. * Taxon tested in preliminary mixing models but excluded from the final models due to negligible contribution

Taxonomic group	*n*	δ^{13}C (mean ± SD)	δ^{15}N (mean ± SD)
Gastropoda	17	-14.63 ± 0.67	15.73 ± 0.91
Decapoda	6	-15.85 ± 0.6	11.82 ± 0.97
Teleostei	15	-17.41 ± 0.7	15.21 ± 0.93
Scyphozoa*	3	-15.32 ± 0.1	14.4 ± 0.17
Salpida	8	-21.03 ± 1.59	4.95 ± 1.56

Table S3. Explanatory variables included in the linear mixed models (LMM) for $\delta^{13}C$ and $\delta^{15}N$. The selected model for each isotope is shown in bold and corresponds to the most parsimonious model among those with similar support based on the second-order Akaike Information Criterion (AICc); models with ΔAICc ≤ 2 were considered equally supported, where ΔAICc represents the difference in AICc between each model and the model with the lowest AICc

Isotope	Model	Explanatory variables	Random	AICc	ΔAICc
$\delta^{13}C$	1	(Null)	Individual	530.27	19.59
	2	Habitat type	Individual	513.01	2.33
	3	**Habitat type and sex**	**Individual**	**510.68**	**0**
	4	Habitat type, sex and their interaction	Individual	510.79	0.11
$\delta^{15}N$	1	(Null)	Individual	907.87	61.51
	2	**Habitat type**	**Individual**	**846.36**	**0**
	3	Habitat type and sex	Individual	846.45	0.09
	4	Habitat type, sex and their interaction	Individual	846.75	0.39

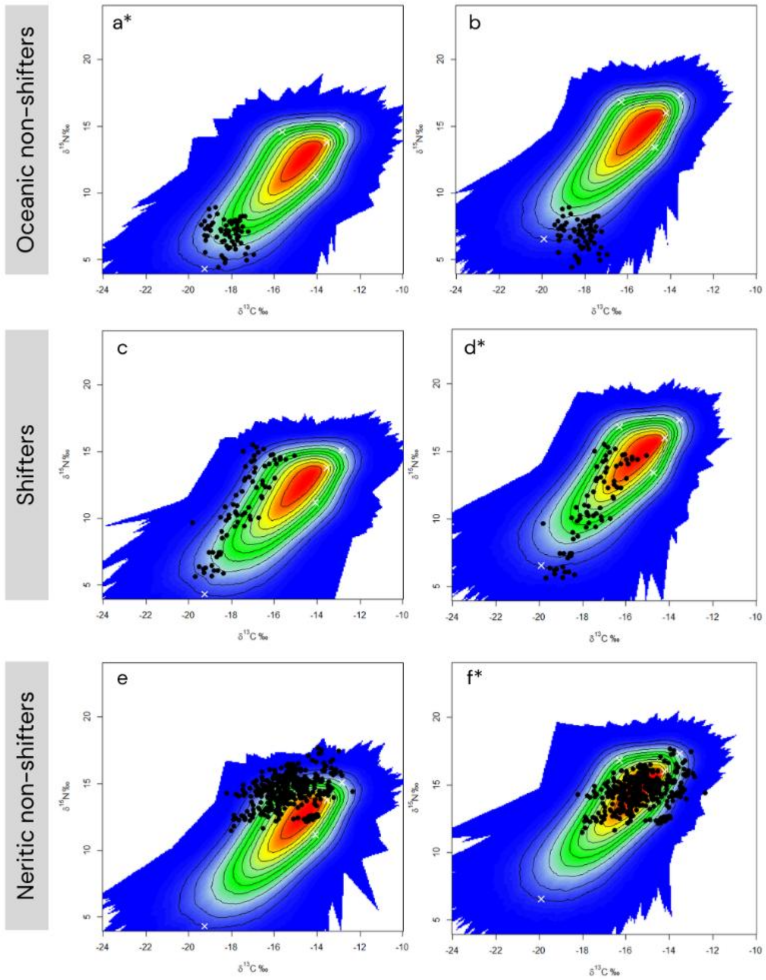

Figure S3. Isotopic mixing polygons using two different sets of TDFs for the correction of prey tissue values. Polygons on the left (a, c, e) use loggerhead scute TDFs (1.77‰ for $\delta^{13}C$ and –0.64‰ for $\delta^{15}N$; Reich et al. 2008), while polygons on the right (b, d, f) use loggerhead skin TDFs (1.11‰ for $\delta^{13}C$ and 1.60‰ for $\delta^{15}N$; Reich et al. 2008). Black dots represent the stable isotope values of individual loggerhead turtles, and white crosses indicate the mean isotopic composition of each prey source. Multicolored polygons represent the simulated mixing region for consumers and prey under each TDF scenario. Black lines represent probability contours at the 10% level. Asterisks (*) indicate the TDF set that provided the best fit for each group

Table S4. Summary table with information of 42 loggerhead turtles (*Caretta caretta*) in the Southwestern Atlantic Ocean (SWAO) between 2013 and 2024. Dates given as yyyy/mm/dd. CCL: curved carapace length. Sex: F = female, M = male, U = unknown. Life stage: Juv = juvenile, Ad = adult. Asterisks (*) indicate recruitment to neritic habitats.

Turtle ID	Country	Date	CCL (cm)	Sex	Life stage	Shift pattern	Layers	$\delta^{13}C$ (‰)		$\delta^{15}N$ (‰)		Source
								first layer	last layer	first layer	last layer	
CCFFA	Brazil	2013/10/11	77.5	U	Juv	Neritic non-shifter	21	-15.94	-16.22	12.84	13.82	Beach
CCII	Brazil	2013/12/19	86	U	Ad	Neritic non-shifter	20	-16.05	-15.02	15.55	14.89	Beach
CCHHB	Brazil	2014/02/05	114	M	Ad	Neritic non-shifter	25	-14.04	-13.24	15.49	15.68	Beach
CCKK	Brazil	2014/02/21	88	F	Ad	Neritic non-shifter	16	-13.66	-13.85	14.42	15.15	Trawl
CCAA	Brazil	2014/03/06	24	M	Juv	Oceanic non-shifter	6	-18.15	-18.26	6.87	7.58	Beach
CCMUYA	Uruguay	2015/02/02	68.5	M	Juv*	Shifter	13	-17.18	-18.13	13.09*	10.24*	Beach
CCJJA	Brazil	2015/03/13	82	U	Juv	Neritic non-shifter	33	-14.21	-14.61	12.31	12.34	Beach
CCJUY	Uruguay	2015/03/29	99.6	M	Ad	Neritic non-shifter	28	-13.64	-13.33	16.26	16.17	Beach
CCP	Brazil	2015/04/07	107.5	M	Ad	Neritic non-shifter	19	-15.52	-14.12	14.65	13.49	Beach
CCLL	Brazil	2015/05/22	79	U	Juv	Neritic non-shifter	20	-15.79	-17.90	15.11	12.63	Trawl
CCBUY	Uruguay	2016/01/04	70.4	F	Juv	Neritic non-shifter	20	-15.57	-16.19	14.19	13.75	Beach
CCHUY	Uruguay	2016/02/04	93.2	F	Ad	Neritic non-shifter	17	-15.04	-15.38	15.05	16.46	Beach
CCRR	Brazil	2016/12/28	85	U	Ad	Neritic non-shifter	35	-15.37	-15.45	15.07	13.66	Beach
CCQQ	Brazil	2016/12/28	105	M	Ad	Neritic non-shifter	39	-14.56	-14.79	15.22	13.94	Beach
CCFUY	Uruguay	2017/01/20	95	F	Ad	Neritic non-shifter	17	-15.75	-16.56	15.58	14.35	Beach
CCAUY	Uruguay	2017/03/11	93.6	F	Ad	Neritic non-shifter	30	-16.28	-16.70	14.03	13.11	Beach
CCKUY	Uruguay	2017/03/11	105	F	Ad	Neritic non-shifter	25	-15.86	-16.05	13.42	15.34	Beach
CCUUY	Uruguay	2017/12/06	75	F	Juv	Indeterminate shifter	25	-15.44	-17.96	14.39	11.55	Beach
CCFFUY	Uruguay	2017/12/12	70.1	F	Juv*	Shifter	25	-16.06	-19.83	14.79*	9.66*	Beach
CCCCUY	Uruguay	2017/12/20	71.9	F	Juv	Neritic non-shifter	12	-16.97	-16.53	12.77	14.56	Beach
CCCAUY	Uruguay	2018/01/21	92.7	M	Ad	Neritic non-shifter	33	-14.49	-14.10	14.60	15.20	Beach
CCDDUY	Uruguay	2018/01/30	63.2	M	Juv*	Shifter non-shifter	19	-16.89	-17.72	13.79*	9.71*	Beach
CCXUY	Uruguay	2019/01/16	75.2	F	Juv	Neritic non-shifter	22	-16.83	-18.02	15.23	11.47	Beach
CCNA	Brazil	2019/03/07	91.5	M	Ad	Neritic non-shifter	15	-15.77	-15.28	13.91	14.11	Beach
CCYA	Brazil	2019/03/21	51.5	M	Juv	Oceanic non-shifter	22	-17.74	-17.55	6.62	6.27	Longline
CCV	Brazil	2019/03/21	69	F	Juv	Indeterminate shifter	26	-18.77	-18.61	9.04	8.62	Longline

CCWUYB	Uruguay	2019/04/21	57.4	F	Juv	Indeterminate shifter	14	-17.99	-19.33	11.18	4.68	Beach
CCTUYA	Uruguay	2019/06/04	103	F	Ad	Neritic non-shifter	23	-15.96	-15.36	15.84	16.28	Beach
CCRUY	Uruguay	2019/11/23	66.1	M	Juv*	Shifter non-shifter	14	-17.02	-18.65	15.51*	6.07*	Beach
CCQUY	Uruguay	2020/01/04	66.9	F	Juv*	Shifter non-shifter	22	-16.95	-19.29	14.71*	5.92*	Beach
CCEEUY	Uruguay	2020/01/17	78	F	Juv	Neritic non-shifter	38	-15.57	-15.36	15.48	15.03	Beach
CCBBUYA	Uruguay	2020/05/24	76.2	M	Juv	Indeterminate shifter	45	-16.03	-16.84	14.95	12.20	Beach
CCSUYA	Uruguay	2021/03/04	73.4	M	Juv	Neritic non-shifter	22	-16.77	-16.11	14.40	14.40	Beach
CCZ	Brazil	2021/06/16	29	U	Juv	Oceanic non-shifter	6	-18.13	-19.04	7.16	8.26	Beach
CCDD	Brazil	2021/06/18	52	M	Juv	Oceanic non-shifter	36	-17.74	-18.62	7.44	4.43	Longline
CCR	Brazil	2021/06/21	66.5	F	Juv	Oceanic non-shifter	23	-19.09	-19.25	7.36	5.55	Beach
CCT	Brazil	2021/06/25	65	F	Juv	Oceanic non-shifter	14	-18.33	-18.71	6.42	6.71	Longline
CCX	Brazil	2022/04/07	102	F	Ad	Neritic non-shifter	15	-13.64	-14.58	14.27	13.97	Beach
CCCCA	Brazil	2022/08/09	59.5	F	Juv*	Shifter	15	-16.56	-17.14	12.79*	10.16*	Longline
CCO	Brazil	2023/01/17	89	M	Ad	Neritic non-shifter	15	-14.14	-14.72	14.65	13.44	Beach
CCZUY	Uruguay	2024/02/19	82.1	M	Juv	Neritic non-shifter	41	-16.59	-16.59	15.90	14.92	Beach
CCAAUY	Uruguay	2024/03/14	62.4	F	Juv	Neritic non-shifter	16	-17.15	-17.44	12.22	14.89	Beach

Table S5. Values of $\delta^{13}C$ (‰) and $\delta^{15}N$ (‰) pre and post-shift to the neritic habitat of shifter individuals of loggerhead turtles (*Caretta caretta*) from the southwestern Atlantic Ocean (SWAO). ID = individual identification code.

Turtle ID	$\delta^{13}C$ pre-shift	$\delta^{13}C$ post-shift	$\delta^{15}N$ pre-shift	$\delta^{15}N$ post-shift	Difference $\delta^{13}C$	Difference $\delta^{15}N$
CCCCA	-17.31	-16.64	10.16	12.29	0.67	2.13
CCMUYA	-18.26	-17.44	10.22	12.41	0.82	2.19
CCQUY	-18.94	-16.89	6.63	14.68	2.05	8.05
CCRUY	-18.60	-17.11	7.56	14.27	1.49	6.71
CCFFUY	-18.39	-16.10	9.26	14.44	2.29	5.19
CCDDUY	-17.54	-16.32	10.06	13.45	1.23	3.40
Mean	**-18.17**	**-16.75**	**8.98**	**13.59**	**1.43**	**4.61**

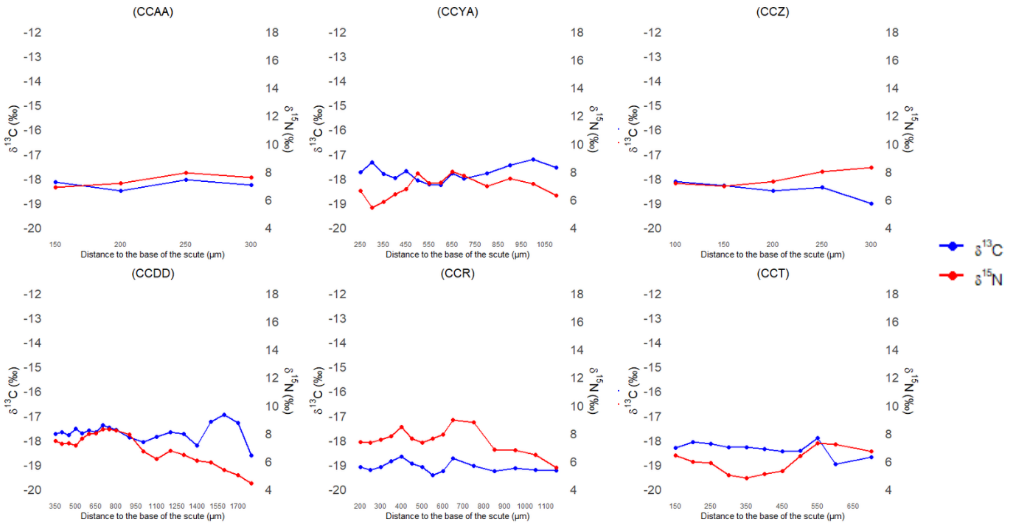

Figure S4. Individual $\delta^{13}C$ (blue) and $\delta^{15}N$ (red) values of oceanic non-shifters (n=6) loggerhead turtles (*Caretta caretta*) from the Southwestern Atlantic Ocean (SWAO). The x-axis represents the distance to the base of the scute (from new to oldest tissue, in µm).

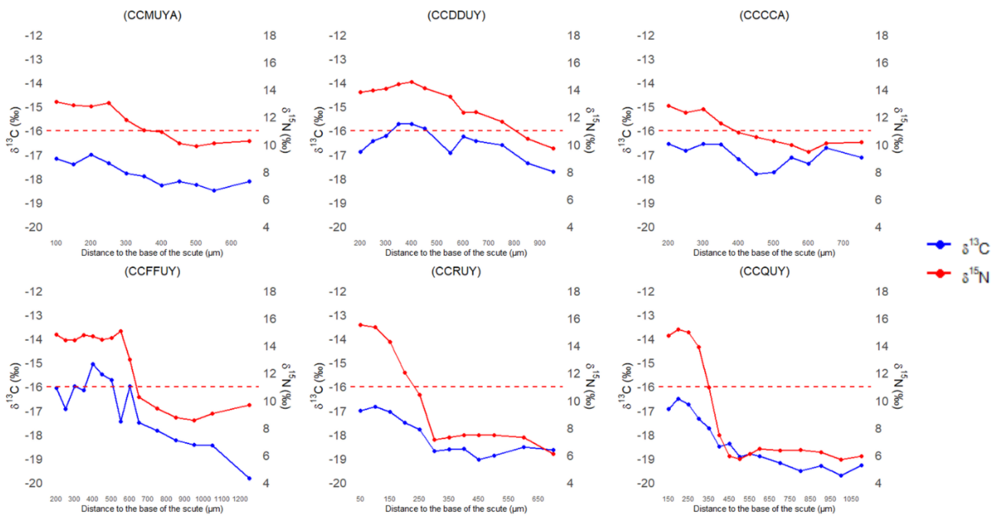

Figure S5. Individual $\delta^{13}C$ (blue) and $\delta^{15}N$ (red) values of shifters (n=6) loggerhead turtles (*Caretta caretta*) from the Southwestern Atlantic Ocean (SWAO). The x-axis represents the distance to the base of the scute (from new to oldest tissue, in µm). The dashed line indicates the $\delta^{15}N$ threshold (10.97‰) separating oceanic and neritic groups. "Facultative shifters" are shown in the top row, and "discrete shifters" in the bottom row.

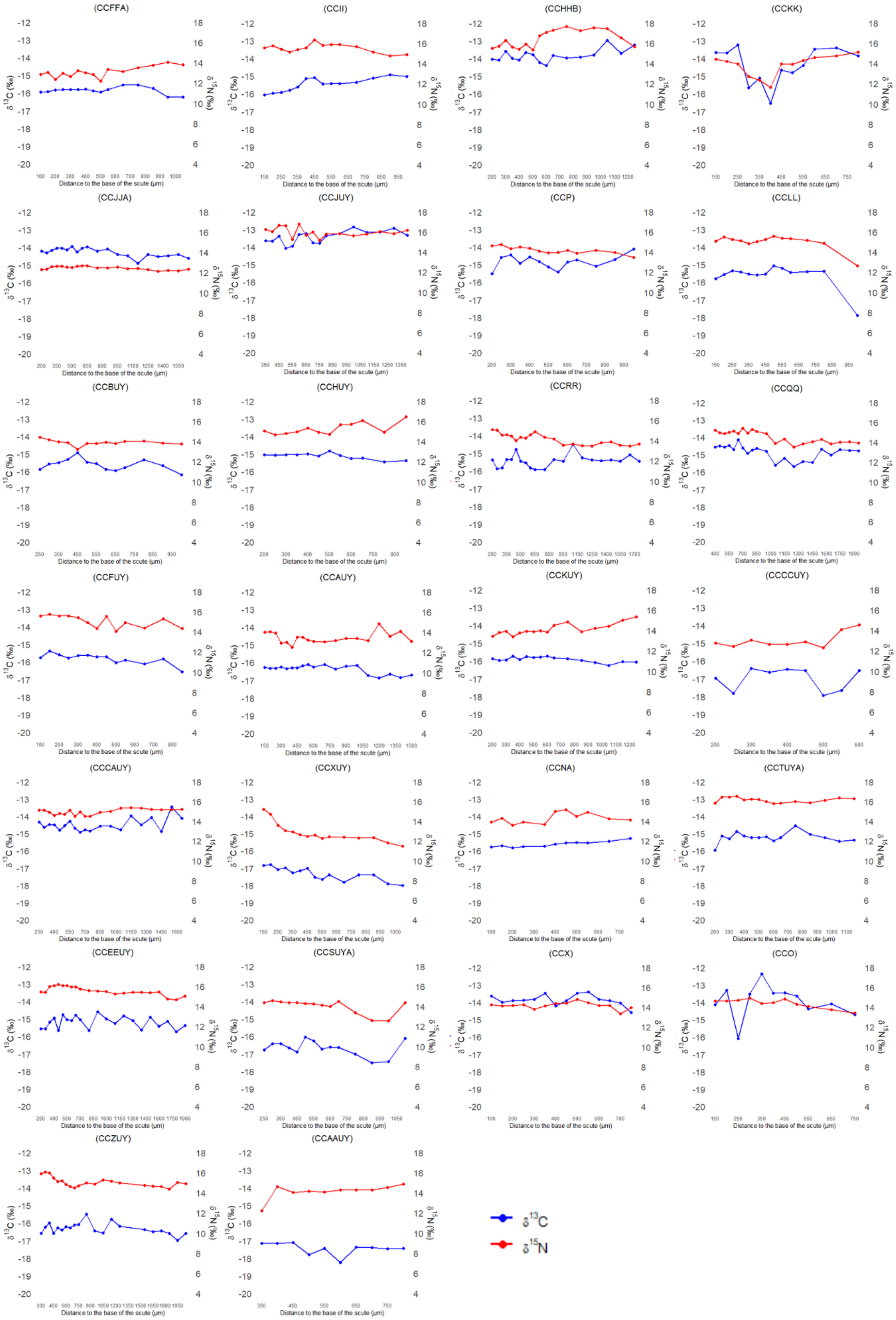

Figure S6. Individual $\delta^{13}C$ (blue) and $\delta^{15}N$ (red) values of neritic non-shifters (n=26) loggerhead turtles (*Caretta caretta*) from the Southwestern Atlantic Ocean (SWAO). The x-axis represents the distance to the base of the scute (from new to oldest tissue, in µm).

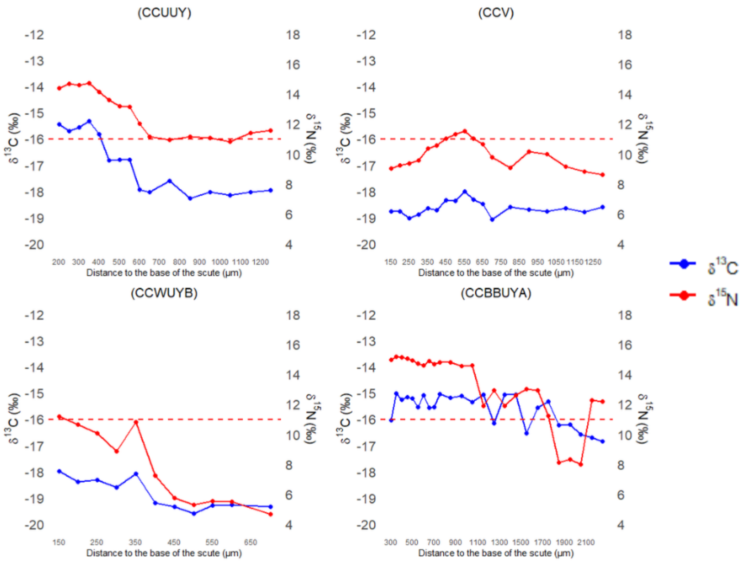

Figure S7. Individual $\delta^{13}C$ (blue) and $\delta^{15}N$ (red) values of indeterminate shifters (n=4) loggerhead turtles (*Caretta caretta*) from the Southwestern Atlantic Ocean (SWAO). The x-axis represents the distance to the base of the scute (from new to oldest tissue, in µm). The dashed line indicates the $\delta^{15}N$ threshold (10.97‰) separating oceanic and neritic groups.