Appendix A. Turtle and prey stable isotope analyses.

Stable Isotope Analysis

Approximately 1.6 mg of bone dust was collected from each annual growth increment (i.e., bone tissue between successive LAGs) and analyzed for $\delta^{15}N$ and $\delta^{13}C$ by a continuous-flow isotope-ratio mass spectrometer in the College of Earth, Ocean, Atmospheric Sciences Stable Isotope Lab at Oregon State University, Corvallis, OR. The system consists of a Carlo Erba NA1500 elemental analyzer interfaced with a DeltaPlusXL isotope-ratio mass spectrometer (Finnigan MAT, Bremen, Germany). Stable isotope ratios of samples relative to the standard are presented in the standard delta (δ) notation as follows:

$$\delta X = [(R_{sample}/R_{standard}) - 1]$$

where X is ^{15}N or ^{13}C and R is the ratio of heavy to light isotopes ($^{15}N/^{14}N$ and $^{13}C/^{12}C$) in the sample and standard, respectively. $R_{standard}$ for $\delta^{15}N$ was atmospheric N_2 and $R_{standard}$ for $\delta^{13}C$ was Vienna Pee Dee Belemnite (VPDB). The internal standard IAEA-600 (Caffeine; isotopic composition of $\delta^{15}N$ = 1.00 ‰ and $\delta^{13}C$ = -27.77 ‰) was calibrated at regular intervals against the international standards. The analytical precision for IAEA-600, measured as the standard deviation around the mean of replicate runs of the internal standard, was 0.10 ‰ for $\delta^{15}N$ and 0.09 ‰ for $\delta^{13}C$. In addition to stable isotope ratios, %N and %C were calculated using mass 28 and mass 44 peak areas, respectively, with a precision of 0.46 % for %N and 0.61 % for %C. The %C and %N values were used to calculate C:N ratios (%C divided by %N) as well as to assess protein purity.

Composite bone samples

In some cases composite samples of two or three narrow growth increments were collected due to our inability to individually sample the narrowest growth increments. Of the 596

bone samples collected, 40 were composites of two (n = 37) or three (n = 3) skeletal growth increments. However, in only seven turtles were composite samples taken at points critical to life history pattern classification. For two of these turtles (one each discrete and facultative shifter), classification was unaffected by the need to evaluate a composite sample, while three other turtles were classified as an indeterminate shifters due to our inability to accurately assign an alternative life history pattern. The remaining two turtles were conservatively classified as discrete shifters based on the composite $\delta^{15}N$ values measured, though may have been classified as facultative shifters had both growth increments been wide enough to sample individually.

TABLE A1. Mean isotopic composition of zooplankton and potential prey items of juvenile loggerhead sea turtles summarized by species and habitat.

Species	*n*†	$\delta^{15}N$ (‰)‡	$\delta^{13}C$ (‰)‡	Source
Neritic species				
Zooplankton	25	8.00	-20.29	2, 3, 6, 7
Molluscs				
Blue mussel *Mytilus edulis*	10	8.83	-20.04	4, 7, 8
Ribbed mussel *Geukensia demissa*	11	7.97	-17.80	5, 7
Moon snail *Neverita duplicata*	1	11.80	-15.40	16
Whelk *Busycon* spp.	11	9.35	-16.87	1, 10
Common periwinkle *Littorina littorea*	3	10.30	-14.60	7
Arthropods				
Blue crab *Callinectes sapidus*	77	9.99	-15.49	1, 4, 5, 7, 10, 12
Spider crab *Libinia emarginata*	16	11.26	-17.63	10, 12
Horseshoe crab *Limulus polyphemus*	20	12.31	-16.80	5, 10, 12
Mantis shrimp *Squilla empusa*	10	12.90	-18.55	16
Mysid shrimp *Neomysis americana*	3	12.95	-20.48	13, 16
Sevenspine bay shrimp *Crangon septemspinosa*	17	13.12	-18.87	16
Fishes (adult, bycatch)				
Atlantic croaker *Micropogonias undulatus*	69	15.48	-19.28	16, 18
Atlantic menhaden *Brevoortia tyrannus*	35	12.97	-18.56	9, 14
Bluefish *Pomatomus saltatrix*	154	15.49	-17.42	5, 10, 16, 18
Oceanic species				
Zooplankton	64	1.93	-19.37	3, 17
Molluscs				
Nudibranch *Scyllaea pelagica*	1	6.70	-20.20	12
Sea snail *Cymbuliidae*	1	5.36	-20.33	15

Arthropods				
Barnacle *Lepas* spp.	1	7.60	-20.00	12
Columbus crab *Planes minutus*	1	6.30	-17.60	12
Sargassum swimming crab *Portunus sayi*	11	5.34	-15.74	11, 12
Brown grass shrimp *Leander tenuicornis*	10	5.02	-16.73	11, 12
Fishes (larval)				
Filefish *Stephanolepis hispidus*	11	6.05	-18.66	11, 12
Yellow Jack *Caranoides bartholomaei*	5	5.41	-17.84	11
Jellyfish				
Mauve stinger jellyfish *Pelagia noctiluca*	8	4.61	-17.95	11
Cannonball jellyfish *Stomolohus meleasgris*	13	8.54	-19.61	10, 12, 15
Moon jellyfish *Aurelia aurita*	5	8.52	-19.50	11
Sea nettle jellyfish *Chrysaora quinquecirrha*	6	5.19	-17.20	11
Lion's mane jellyfish *Cyanea capillata*	1	5.29	-17.46	11

Sources are: 1, Peterson & Howarth (1987); 2, Fry (1988); 3, Fry and Quinones (1994); 4, Fantle et al. (1999); 5, Knoff et al. (2001); 6, Estrada et al. (2003); 7, Dittel et al. (2006); 8, Haramis et al. (2007); 9, Logan (2009); 10, Wallace et al. (2009); 11, McClellan et al. (2010); 12, Snover et al. (2010); 13, Woodland et al. (2011); 14, Szczebak and Taylor (2011); 15, Dodge et al. (2011); 16, Buchheister & Latour (2011); 17, Mompean et al. (2013); 18, Xu et al. (2013).

†Collective sample size from source literature.

‡Means are weighted by sample size.

TABLE A2. Mean (± SD) skeletal growth increment-specific $\delta^{13}C$ values by life history pattern and shift duration for juvenile loggerhead sea turtles.

Life history pattern	n	Pre-shift (‰)	Post-shift (‰)	Difference (‰)	|Difference (‰)|
All ontogenetic shifters†	38	-16.06 ± 0.50	-16.23 ± 1.10	-0.17 ± 1.06	0.83 ± 0.66
Discrete shifters	24	-15.93 ± 0.41	-16.27 ± 1.28	-0.33 ± 1.12	0.87 ± 0.76
Facultative shifters	14				
All durations	14	-16.23 ± 0.61	-16.19 ± 0.88	0.04 ± 1.03	0.82 ± 0.59
2 years	9	-16.26 ± 0.71	-16.38 ± 0.79	-0.12 ± 0.98	0.75 ± 0.59
3 years	3	-16.17 ± 0.37	-16.07 ± 0.96	0.11 ± 1.21	0.82 ± 0.68
4 years	1	-16.16	-14.67	1.49	1.49
5 years	1	-15.74	-15.20	0.54	0.54
Non-shifters‡	24				
Oceanic	16	-17.20 ± 1.05	-15.96 ± 0.36		
Neritic	8	-15.84 ± 0.78	-14.30 ± 1.01		
Indeterminate shifters‡	22	-17.07 ± 0.89	-15.83 ± 0.76		

†Combined data for *discrete* and *facultative shifters.*

‡Presented are mean minimum and maximum $\delta^{13}C$ values of sampled growth increments within turtles.

LITERATURE CITED

Buchheister, A., and R. J. Latour. 2011. Trophic ecology of Summer Flounder in Lower Chesapeake Bay inferred from stomach content and stable isotope analyses. Transactions of the American Fisheries Society 140:1240–1254.

Dittel, A. I., C. E. Epifanio, and M. L. Fogel. 2006. Trophic relationships of juvenile blue crabs (*Callinectes sapidus*) in estuarine habitats. Hydrobiologia 568:379–390.

Dodge, K. L., J. M. Logan, and M. E. Lutcavage. 2011. Foraging ecology of leatherback sea turtles in the Western North Atlantic determined through multi-tissue stable isotope analyses. Marine Biology 158:2813–2824.

Estrada, J. A., A. N. Rice, M. E. Lutcavage, and G. B. Skomal. 2003. Predicting trophic position in sharks of the North-West Atlantic Ocean using stable isotope analysis. Journal of the Marine Biological Association of the United Kingdom 83:1347–1350.

Fantle, M. S., A. I. Dittel, S. M. Schwalm, C. E. Epifanio, and M. L. Fogel. 1999. A food web analysis of the juvenile blue crab, *Callinectes sapidus*, using stable isotopes in whole animals and individual amino acids. Oecologia 120:416–426.

Fry, B. 1988. Food web structure on Georges Bank from stable C, N, and S isotopic compositions. Limnology and Oceanography 33:1182–1190.

Fry, B., and R. B. Quinones. 1994. Biomass spectra and stable isotope indicators of trophic level in zooplankton of the northwest Atlantic. Marine Ecology Progress Series 112:201–204.

Haramis, G. M., W. A. Link, P. C. Osenton, D. B. Carter, R. G. Weber, N. A. Clark, M. A. Teece, and D. S. Mizrahi. 2007. Stable isotope and pen feeding trial studies confirm the value of horseshoe crab *Limulus polyphemus* eggs to spring migrant shorebirds in Delaware Bay. Journal of Avian Biology 38:367–376.

Knoff, A. J., S. A. Macko, and R. M. Erwin. 2001. Diets of nesting laughing gulls (*Larus atricilla*) at the Virginia Coast Reserve: observations from stable isotope analysis. Isotopes in Environmental and Health Studies 37:67–88.

Logan, J. 2009. Tracking diet and movement of Atlantic bluefin tuna (*Thunnus thynnus*) using carbon and nitrogen stable isotopes. University of New Hampshire, Durham, New Hampshire, USA.

McClellan, C. M., J. Braun-McNeill, L. Avens, B. P. Wallace, and A. J. Read. 2010. Stable isotopes confirm a foraging dichotomy in juvenile loggerhead sea turtles. Journal of Experimental Marine Biology and Ecology 387:44–51.

Mompean, C., A. Bode, V. M. Benitez-Barrios, J. F. Dominguez-Yanes, J. Escanez, and E. Fraile-Nuez. 2013. Spatial patterns of plankton biomass and stable isotopes reflect the influence of the nitrogen-fixer *Trichodesmium* along the subtropical North Atlantic. Journal of Plankton Research 35:513–525.

Peterson, B. J., and R. W. Howarth. 1987. Sulfur, carbon, and nitrogen isotopes used to trace organic matter flow in the salt-marsh estuaries of Sapelo Island, Georgia. Limnology and Oceanography 32:1195–1213.

Snover, M., A. Hohn, L. Crowder, and S. Macko. 2010. Combining stable isotopes and skeletal growth marks to detect habitat shifts in juvenile loggerhead sea turtles *Caretta caretta*. Endangered Species Research 13:25–31.

Szczebak, J. T., and D. L. Taylor. 2011. Ontogenetic patterns in bluefish (*Pomatomus saltatrix*) feeding ecology and the effect on mercury biomagnification. Environmental Toxicology and Chemistry 30:1447–1458.

Wallace, B. P., L. Avens, J. Braun-McNeill, and C. M. McClellan. 2009. The diet composition of immature loggerheads: Insights on trophic niche, growth rates, and fisheries interactions. Journal of Experimental Marine Biology and Ecology 373:50–57.

Woodland, R. J., D. H. Secor, and M. E. Wedge. 2011. Trophic resource overlap between small Elasmobranchs and sympatric Teleosts in Mid-Atlantic Bight nearshore habitats. Estuaries and Coasts 34:391–404.

Xu, X., M. C. Newman, M. C. Fabrizio, and L. Liang. 2013. An ecologically framed mercury survey of Finfish of the Lower Chesapeake Bay. Archives of Environmental Contamination and Toxicology 65:510–520.

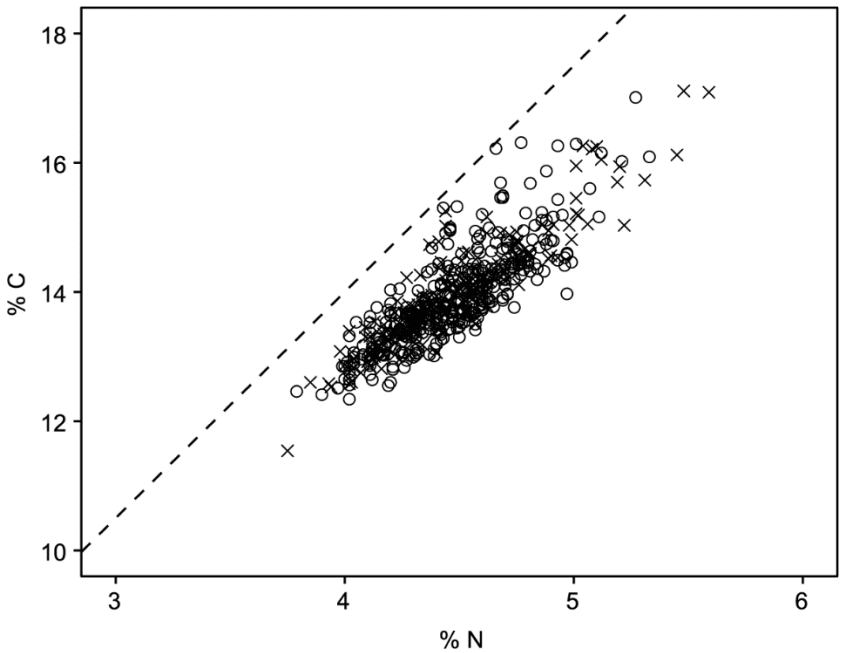

FIG. A1. C:N ratios (i.e., %C divided by %N) of annual skeletal growth increments. Threshold of C:N = 3.5 shown as dashed diagonal line.

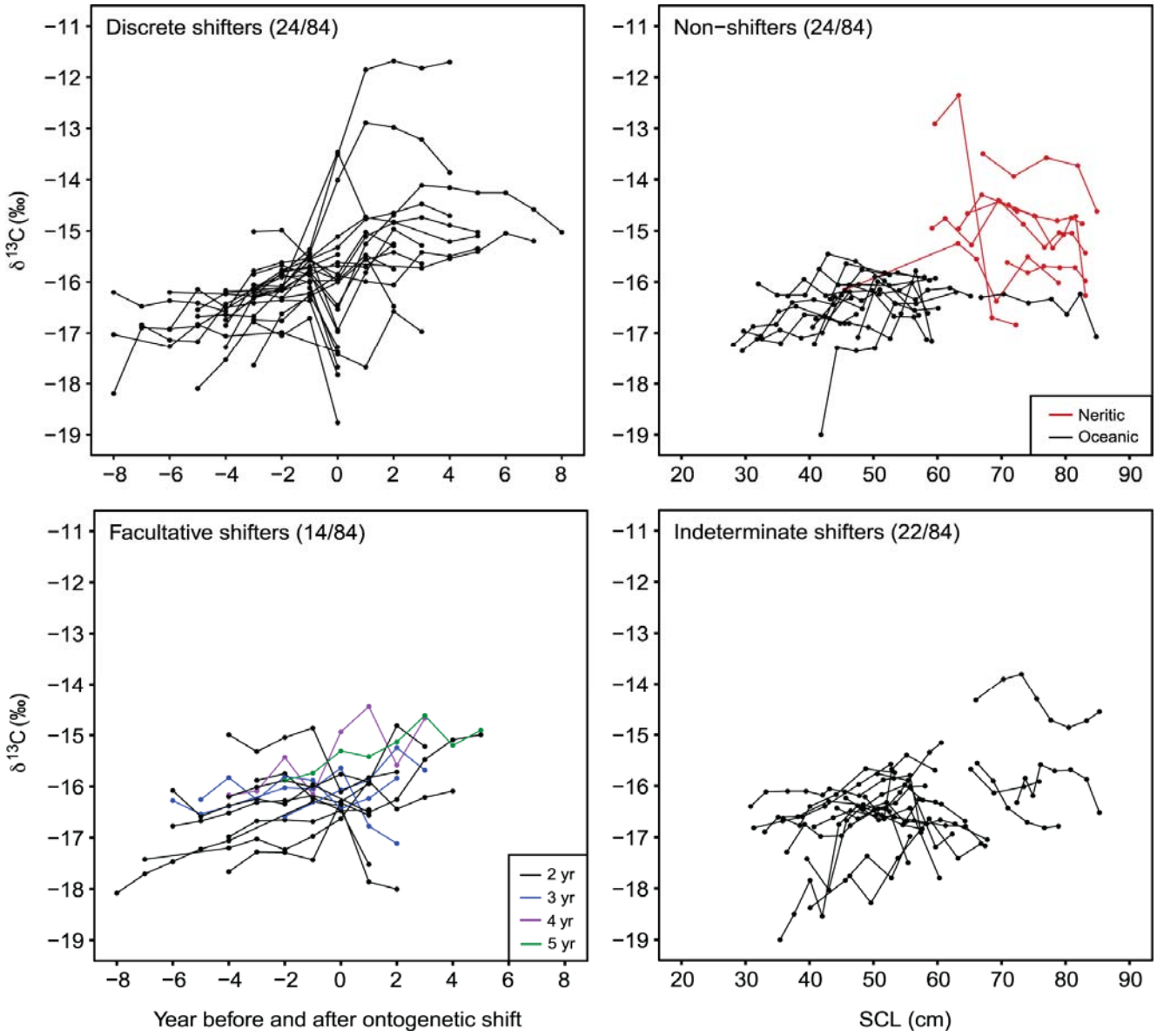

FIG. A2. Turtle-specific carbon stable isotope transects by life history pattern. Plots represent sampled growth increments (points) within turtles (lines). Based on $\delta^{15}N$ values, discrete shifters and facultative shifters showed evidence of an ontogenetic shift in diet and habitat (i.e., ≥ 3 ‰ increases in $\delta^{15}N$ values over one, discrete shifter, or more, facultative shifter, years). Non-shifters exhibited no ontogenetic shift, while indeterminate shifters could not be classified due to insufficient data.