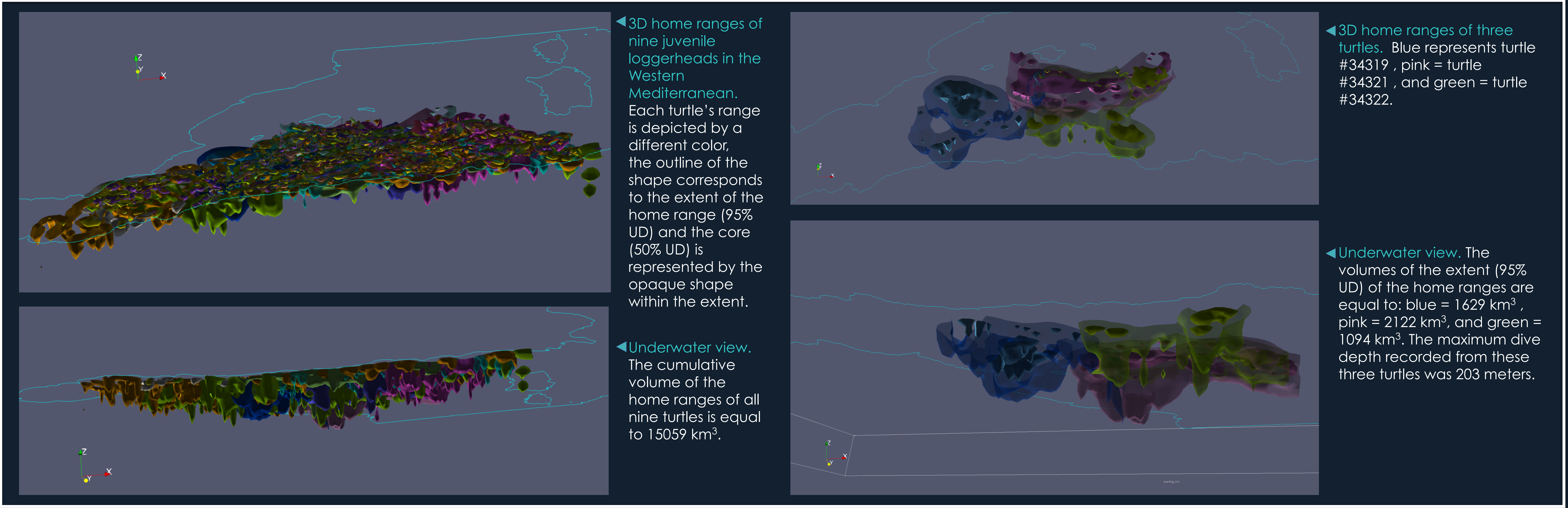


Estimating 3D home ranges of sea turtles using time-depth-recorders

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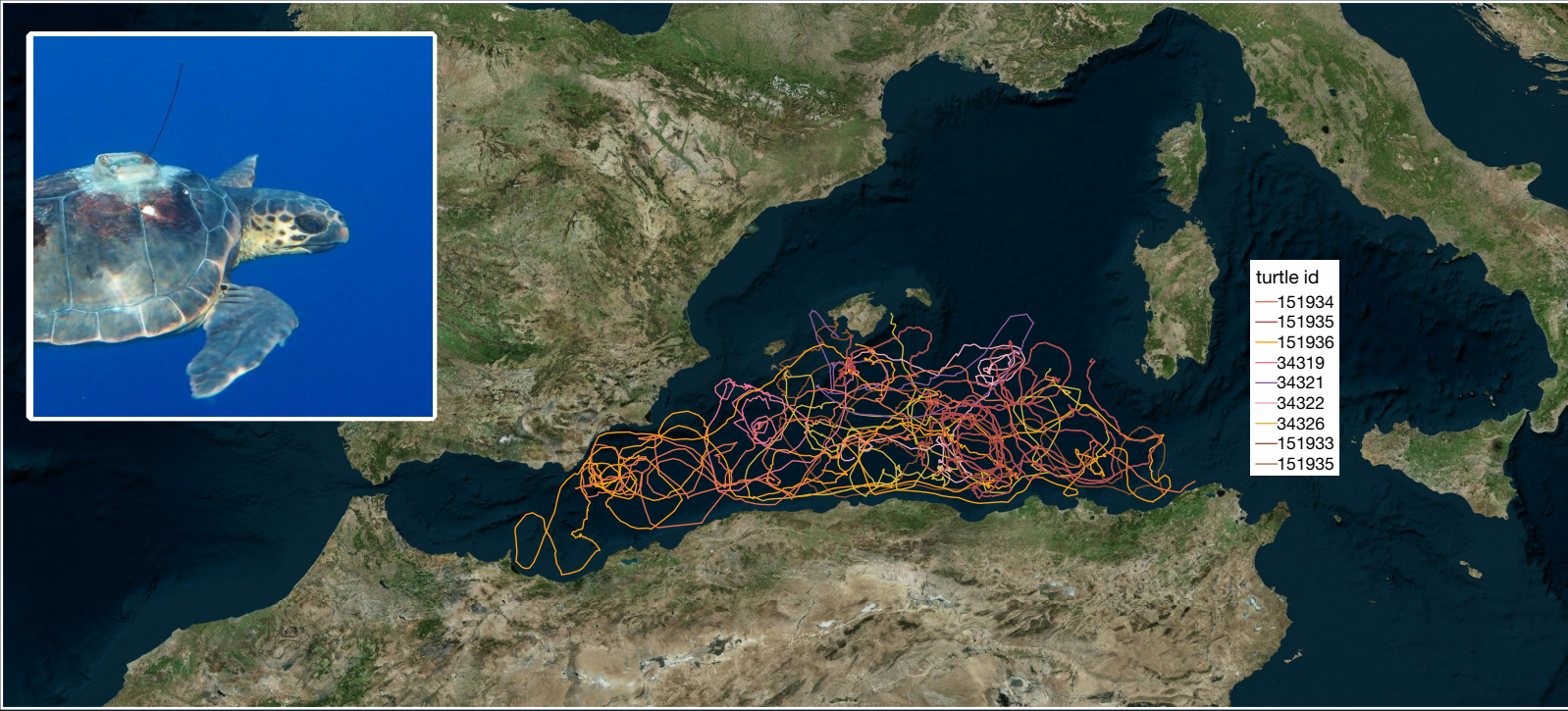
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OBJECTIVE To better describe the habitat use and foraging behavior of juvenile loggerhead sea turtles in the Western Mediterranean. Marine turtles live in a three dimensional environment and to fully understand their movement ecology, it is essential to take the vertical component into account. This study seeks to employ novel **movement-based methods** to estimate the **3D home ranges** of loggerhead sea turtles for the first time.

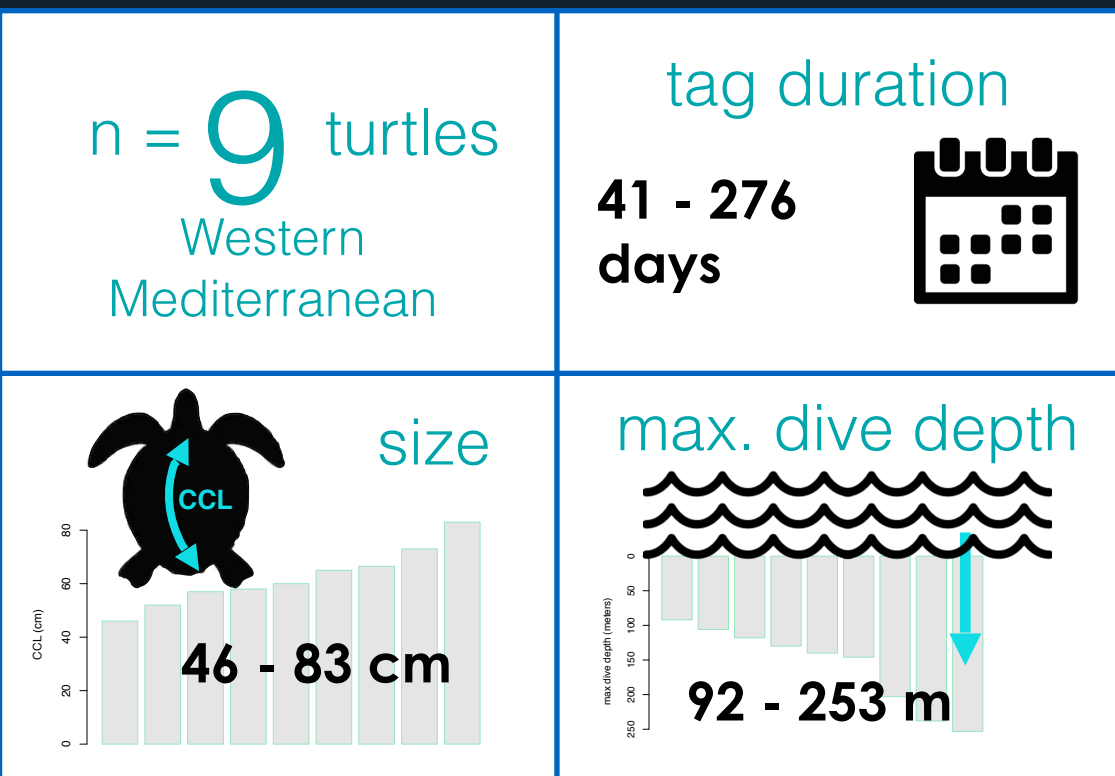


METHODS

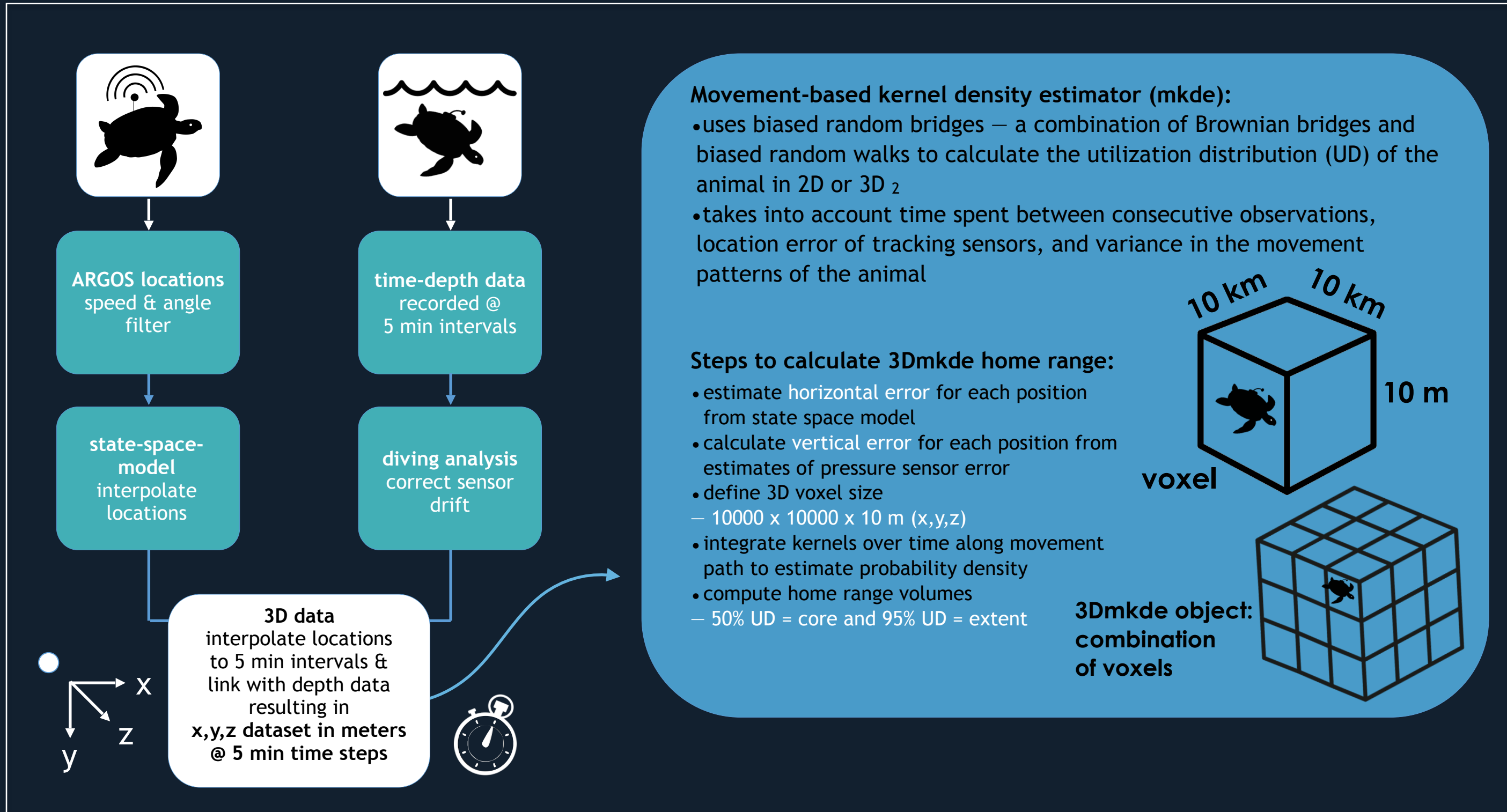
In the Balearic Sea, between August 2015 and March 2018, nine loggerhead turtles were equipped with Argos time temperature depth recorders (TTDR) (SPLASH tags, Wildlife Computers). Seven of the turtles were captured by hand and the other two were rescued by the Palma Aquarium marine rescue center, and later released after tagging. Sensor data was transmitted via satellite through the Argos system, and then processed, the resulting datasets were used to calculate both 3D and 2D home ranges using the 'mkde' package in the R environment.



Tracks of all turtles used in the analysis and photo of Cannoli (turtle #34326)



DATA PROCESSING

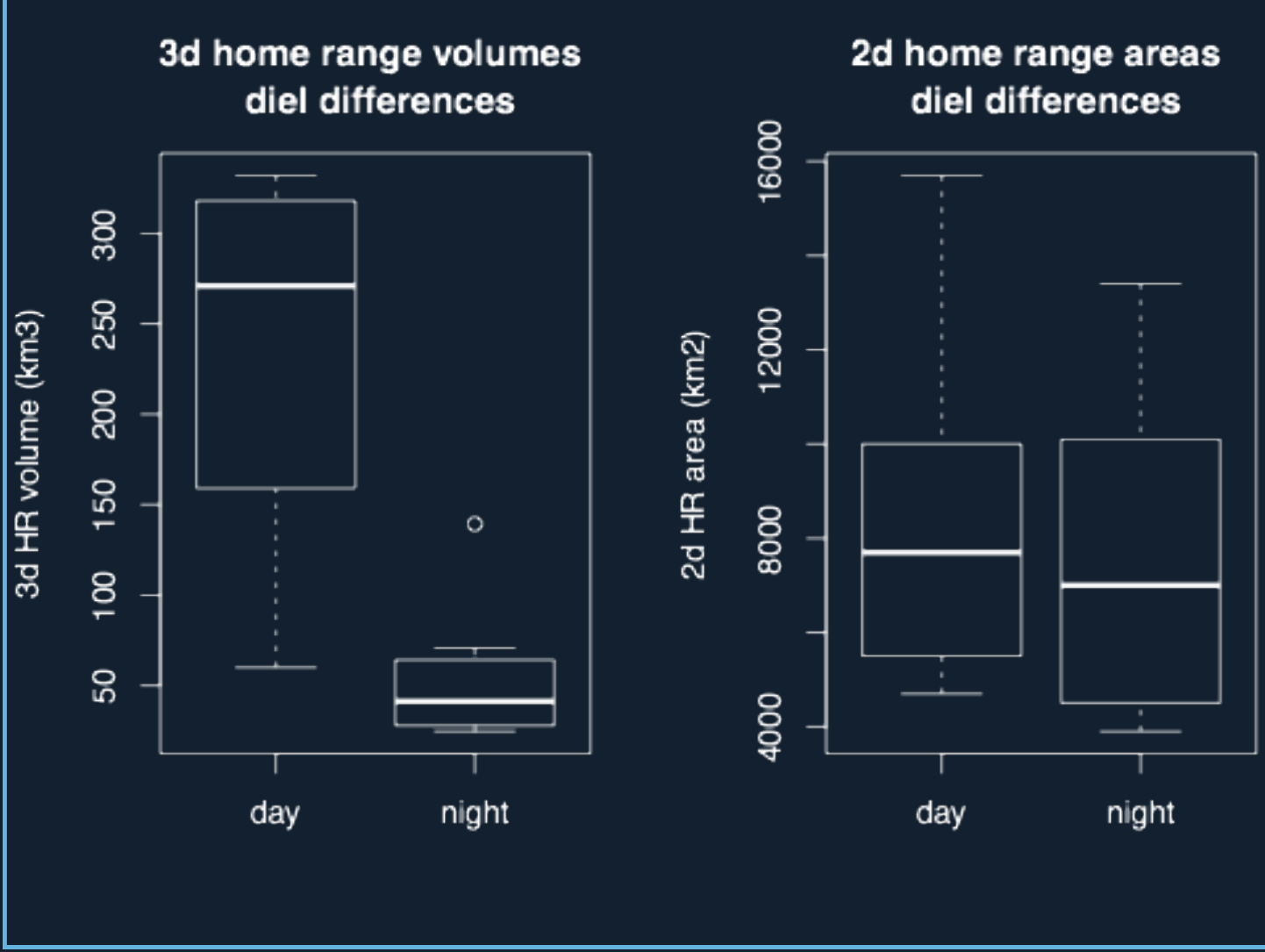


Data processing methods and summary of mkde calculation

RESULTS

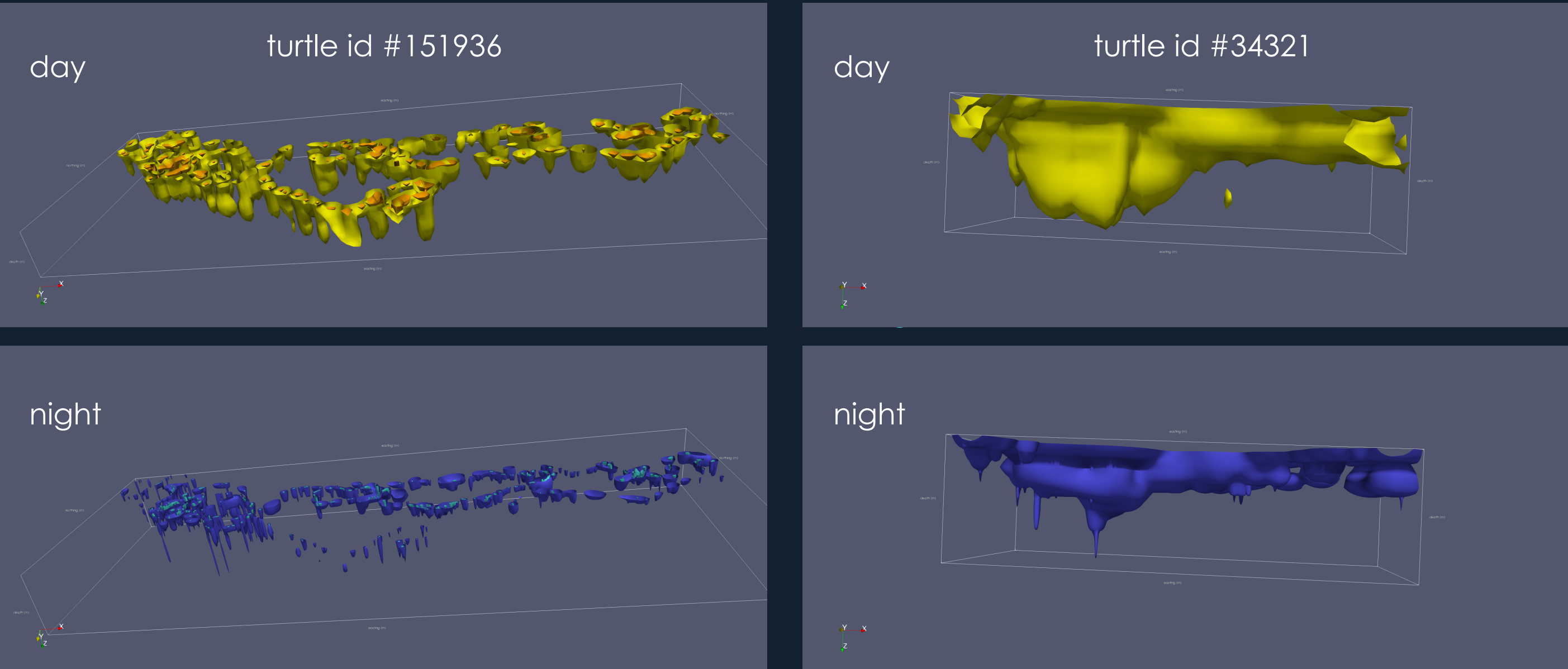
3D home range volumes and 2D home range areas were calculated for all individuals, see table below. Then datasets were split and separate home ranges for day and night were estimated.

	3D volume (km³)		2D area (km²)	
	mean	SD	mean	SD
core home range 50% UD	226.3	95.9	9500.0	4086.3
home range extent 95% UD	1673.2	572.9	42822.2	16601.8



3D home ranges capture diel habitat use patterns. 3D home ranges are significantly larger during the day compared to the night (t-test, df = 10, p < 0.0005). 2D home range areas do not show a significant diel difference.

DIET HABITAT USE



3D home range visualizations for two different individuals. For turtle 151936 yellow indicates the home range extent (95% UD), and orange represents the core (50% UD), and for the night range, dark blue and light blue represent the extent and core respectively. The daytime volume of the home range extent of turtle #151936 was 2238 km³ compared to a night extent of 560 km³. For turtle #34321 the daytime extent was 2413 km³ and the night extent 1212 km³.

DISCUSSION During their oceanic foraging stage, juvenile loggerheads are wide-ranging and elusive animals, however with the aid of biotelemetry devices and new computational methods, we can shed light on their habitat use and movement patterns. The turtles in this study exhibited much larger 3D home range volumes during the day than at night, and this difference would be difficult to detect with 2D methods. These preliminary findings call for the integration of oceanic variables into the analysis and further assessment of the spatial and temporal overlap of marine turtle 3D habitats with anthropogenic threats such as various fishing gear and exposure to pollutants and plastic debris.