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Lagrangian modeling of the active dispersal of juvenile leatherback turtles in the North Atlantic Ocean

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It has long been assumed that young sea turtles drift passively with ocean currents. As a consequence, simple Lagrangian models have often been used to investigate the dispersal of various sea turtle populations during their juvenile stage. However, evidence is growing that juvenile sea turtles do not drift purely passively with ocean currents but also display some swimming activity, generally directed towards favorable habitats.

We have thus developed a new Sea Turtle Active Movement Model (STAMM) in which simulated individuals disperse under the combined influence of oceanic currents and swimming movements triggered by the need to find suitable habitats, that is areas with suitable water temperatures and sufficient food. Preferred temperatures and food requirements are modeled to vary with the age (or size) of the simulated individuals.

STAMM is used here to investigate the active dispersal of juvenile leatherback turtles (Dermochelys coriacea) born in French Guiana, a major rookery for the Northwest Atlantic population. Our simulations reveal that:

- While currents broadly shape the dispersal area, habitat-driven movements profoundly structure the spatio-temporal distribution of juveniles within this area. Passive turtles can drift far North in deadly cold waters or concentrate in oligotrophic waters found at the center of the North Atlantic subtropical gyre. On the contrary, actively swimming juveniles tend to concentrate in favorable habitats along the northern boundary of the subtropical gyre and undertake seasonal north-south migrations allowing them to remain in suitable water temperatures.
- Active juveniles ultimately target rich areas of the Eastern Atlantic basin, in particular in the Bay of Biscay, off Galicia, Portugal and Mauritania, and in the western Mediterranean Sea where juvenile leatherbacks are actually observed. These zones are inaccessible to passive turtles.
- Arrival times of the active juveniles in these favorable zones are consistent with the observed sizes of individuals bycaught or stranded in these areas;

All together these results suggest that active habitat-driven swimming movements shall be systematically taken into account to produce realistic simulations of the spatial distribution of sea

turtles during their pelagic juvenile stage. This is much needed to help develop effective conservation measures targeting this critical life stage.