Re-tying the knot: Step selection in complex landscapes

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Shorebirds gather in huge non-breeding flocks on the islands and intertidal mudflats of the Dutch Wadden Sea. Here, waders such as red knots *Calidris canutus* comb the substrate for accessible buried macrozoobenthos during fleeting windows of opportunity created by the tidal cycle. Foraging in groups at the waterline allows knots to avoid predation and increase efficiency in locating and assessing the quality of food patches, but comes with the costs of competition. Knots must balance these costs and benefits against their intrinsic tendency for exploration, which has been shown to influence space use and prey preference in the lab and field. Modern, high-capacity animal tracking methods, the long-term Synoptic Intertidal BEnthic Survey (SIBES) and controlled testing of knots for exploration scores have increased the quality and quantity of information from this system to unprecedented levels. This enables the investigation of the drivers of wader movement in ways unavailable to previous studies.

Here, we present the system and work in progress that takes advantage of the capacities accumulated therein: advanced high-frequency tracking using ATLAS Time of Arrival tags (135 red knots tracked over 2 months at 0.25 Hz frequency), periodic, high resolution benthic sampling (250 m grid over 20 km^2 of the tracking area), and experimental measurements of exploration scores of the same individuals later released with ATLAS tags. We first simulate knot movement in a tidal system, implementing scenarios that model different combinations of drivers --- periodic variation in the area available for exploitation due to the tidal cycle, a spatially variable and ever-depleting resource landscape, changeable densities of conspecifics responding to the tide and to resource depletion, and consistent individual differences in exploratory tendency. We test the extent to which first each driver alone, and then additive combinations of drivers predict the step selection of red knots. We then compare the results to step selection in empirical data from the ATLAS system, and thereby aim to tease apart how red knots decide on when and where to move in complex landscapes.