

Supporting Information

Model performance

Performance metrics

Performance of the geolocation model was evaluated using the information on acoustic detections. For tags resulting in both archival and acoustic data, the trajectory was reconstructed with and without the detection likelihood. The following metrics were calculated (Table S2, Fig. S1): positional accuracy, defined as the distance between the known receiver location and the trajectory as estimated by the geolocation model without including the acoustic detections, and track sensitivity, defined as distance between the entire trajectories reconstructed with and without implementing the detection likelihood. Both metrics were calculated as timed (distance to the estimated position at the exact day) and non-timed (minimum distance to the estimated positions at all days). All metrics were computed in kilometres using the great circle distance (Gatti *et al.* 2021).

Table S2 – Definition of geolocation model performance metrics.

	Positional accuracy	Track sensitivity
Timed	Distance between receiver location and estimated daily position <i>on the date of detection</i>	Distance between daily positions estimated from models with and without acoustic detections, <i>on the same date</i>
Non-timed	Minimum distance between receiver location and estimated daily positions <i>on all dates</i>	Minimum distance between daily positions estimated from models with and without acoustic detections, <i>on all dates</i>

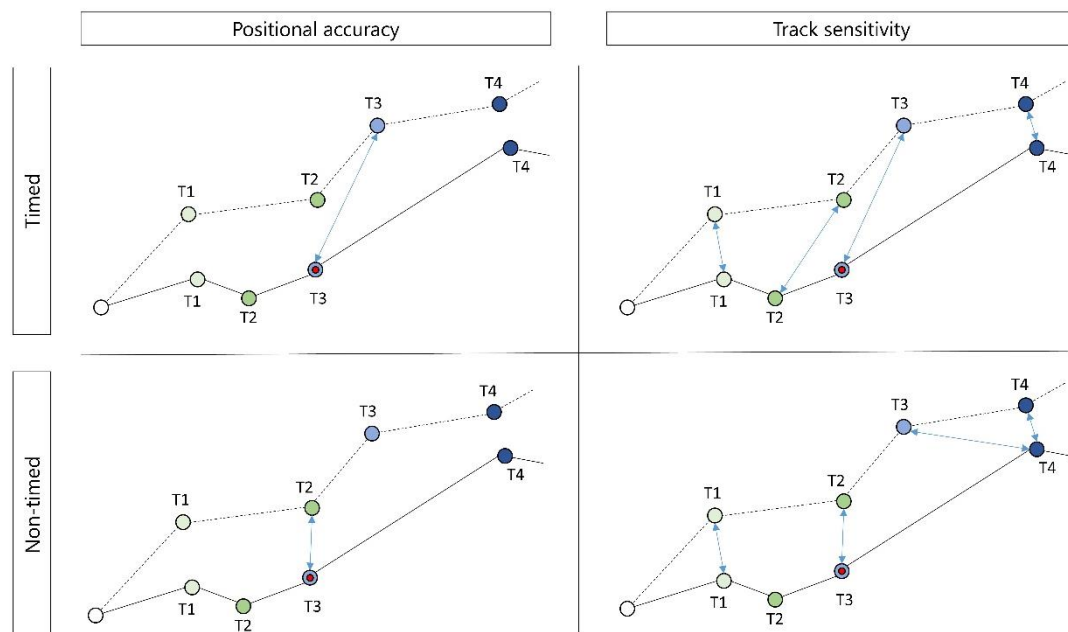


Figure S1 – Visual explanation of performance metrics for evaluating the geolocation model. In this situation, the tagged fish was detected at day T3 (red dot). The trajectory was reconstructed without the information of the acoustic detection (dotted line) and with using the detection likelihood (undashed line). Blue arrows indicated which distance was used to calculate each metric. Positional accuracy was calculated as the distance between the receiver location and the daily position estimate for the day of the detection (timed) or the closest daily position estimate of the track (non-timed). Track sensitivity was calculated as the distance between daily position estimates of the same dates (timed) and as the minimum distance between daily position estimates of all dates (non-timed).

Illustrative example

Below, we illustrated the results of the performance metrics over time (Fig. S2) and in space (Fig. S3), used the shark example (tag SN1293308). The tracks calculated with and without using the detection likelihood were nearly identical up until the end of March 2019. From April onwards, the two estimated tracks diverge up to 50 km distance in space. The detection information also informed the geolocation model that the fish had returned to the Belgian Part of the North Sea earlier than estimated without the information of the acoustic detections.

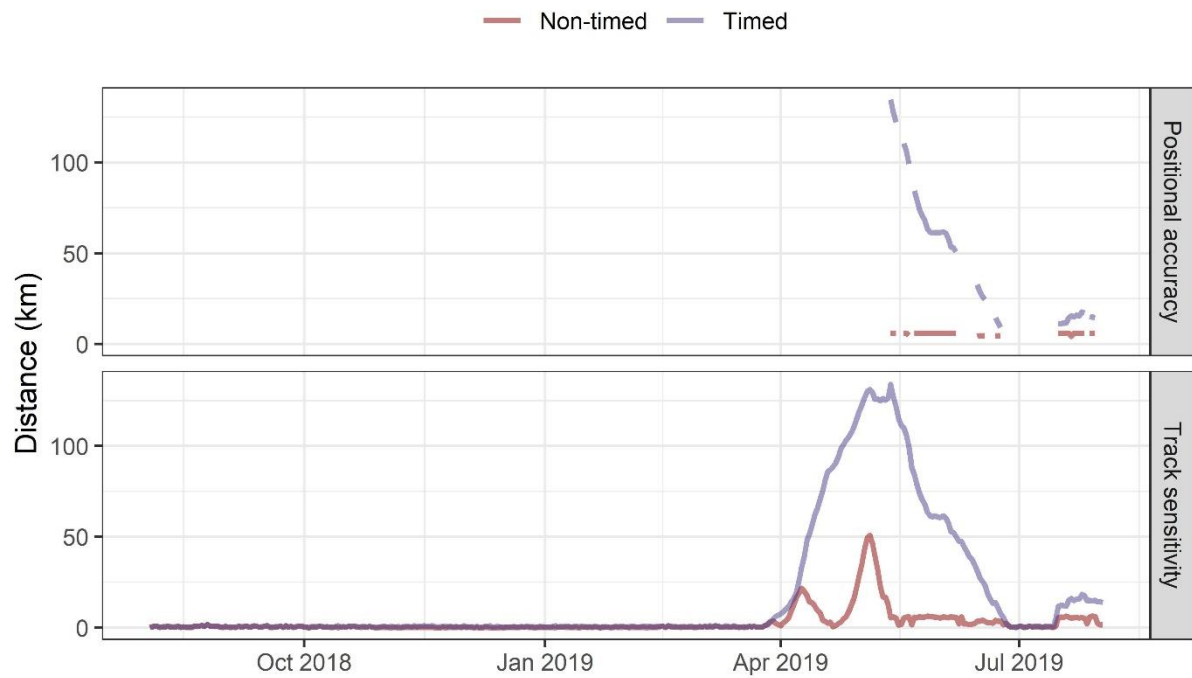


Figure S2 – Performance metrics positional accuracy and track sensitivity, timed (purple) and non-timed (red), over time for the shark example (tag SN1293308).

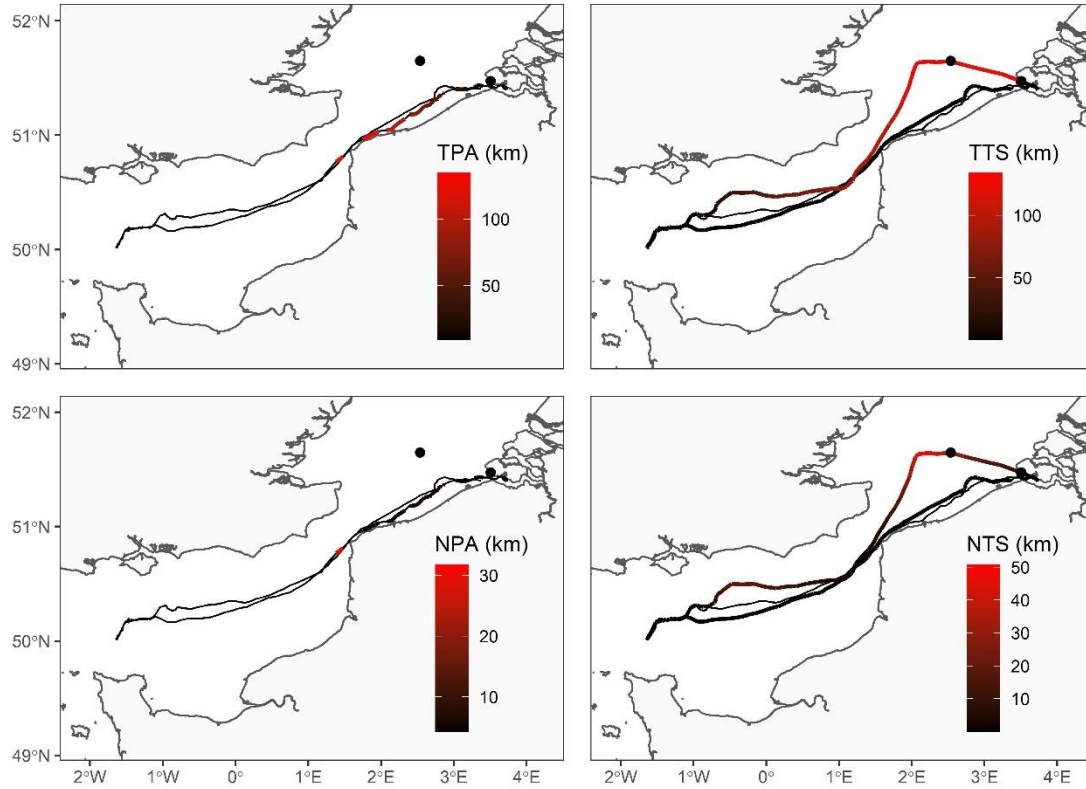


Figure S3 – Performance metrics timed (TPA, top left) and non-timed positional accuracy (NPA, bottom left) and timed (TTS, top right) and non-timed track sensitivity (NTS, bottom right) for the shark example (tag SN1293308). The displayed track (thin black line) was reconstructed without using the detection likelihood. Receiver locations with acoustic detections were displayed as black dots. For positional accuracy (left), the daily position estimates of dates with a detection were displayed with a thick line in a colour scale of the distance (km) from the receiver location to the daily position estimate of the same date (timed) and of all dates (minimum distance, non-timed). For track sensitivity (right), the track reconstructed with the inclusion of the detection likelihood was displayed with a thick line in a colour scale of the distance (km) to the daily position estimates of the track reconstructed without using the detection likelihood (thin black line).